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ATALA

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Articles

Some Extinct Molluscs of the U. S. A.

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Abstract

A synoptic historical review of mollusc extinctions during the past century in the USA is presented, with focus on taxa of riverine, insular, and spring habitats. Dam construction and pollution prove to have been potent factors in the alteration of aquatic habitats, and concomitantly in loss of many mollusc species in the southeastern USA; destruction of the native flora and the introduction of exotic plants and predators have contributed to the decimation of terrestrial molluscs, especially on the Hawaiian Islands.

Introduction

Alteration of pristine habitats has been occuring in areas of the United States ever since the first Europeans arrived, and as a result, many animals have become extinct. My goal in this paper is to draw attention to the past extinctions and present conservational problems faced by molluscs in the United States, an often little publicized but important group of invertebrates.

Molluscs as a group have a tendency to be very localized, and have suffered a large number of extinctions as unique and diverse habitats have been destroyed. The molluscs which have become extinct in the United States during the past one hundred years can conveniently be classified into three groups: those of riverine habitats, island habitats, and spring or pond habitats. The main factors that caused extinctions among riverine taxa have been stream impoundment and pollution. Extinctions among island molluscs can be attributed to habitat destruction, the effects of introduced plants and animals, and overcollecting. Species inhabiting springs and ponds have been affected primarily by habitat destruction.

Riverine Species: The Southeastern USA

The molluscan faunas of the river systems of the southwestern United States are remarkable, particularly those of the Coosa and Tennessee Rivers (see Figure 1). No other area in the world can match the endemic gastropod fauna of the Coosa River drainage or the endemic bivalve fauna of the Tennessee River drainage. Unfortunately, however, the mollusc faunas of these and other United States rivers have been decimated during the twentieth century (refer to Table 1 for a synopsis of these and other extinctions covered in this paper).

Pleuroceridae

The endemic Coosa River genus *Gyrotoma* of the family Pleuroceridae (river snails) is extinct. Goodrich (1924) noted that this genus was endemic only to the main channel of the river, confined to approximately the lower two thirds of the river. This genus was adapted to swiftly flowing water (Ahearn, 1947), which may explain its limited range.

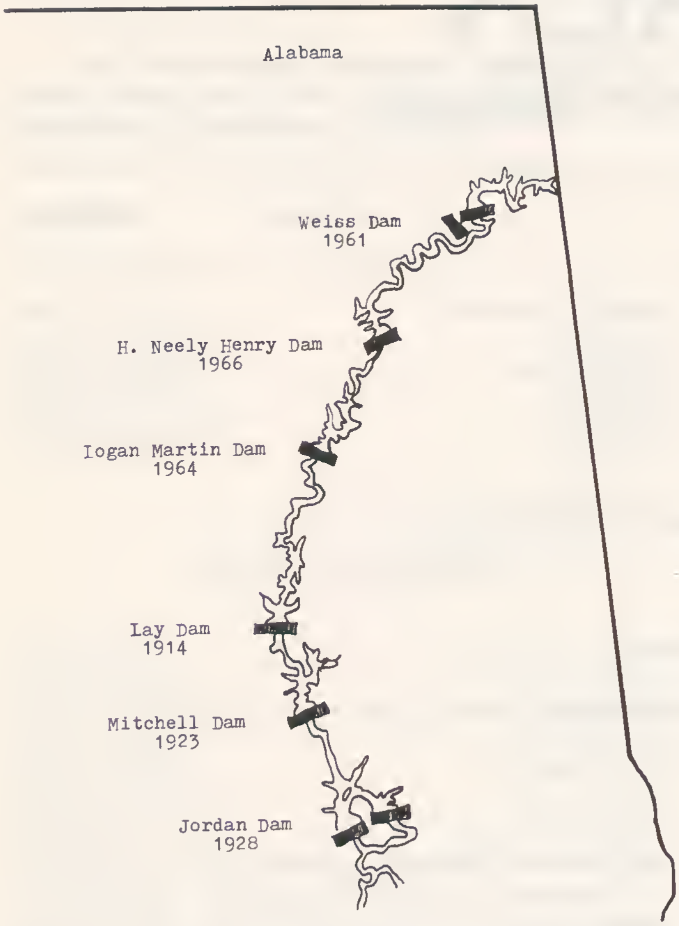

Figure 1. Coosa River system, eastern and central Alabama, USA. Construction dates indicated for the major dams on the river.

It is thought that all of the endemic Coosa River drainage species in the genus *Goniobasis* (= *Elimia*) are extinct (G. M. Davis, pers. comm.), although some species still survive in the unflooded portions of a few tributaries. This genus lived in the main stem of the Coosa River and its tributaries, generally in the upper half of the drainage system (Goodrich, 1944a). Two species of this genus, *Goniobasis catenoides* and *G. boykiniana*, were endemic to the Chatahoochee River system in Georgia. Both were severely affected by siltation which resulted from agricultural activities (Clench & Turner, 1956), and *G. boykiniana* was also eliminated in one area by an impoundment (Stein, 1967).

All species in the genus *Leptoxis* from the Alabama River drainage, which includes the Coosa River system, are endemic (Goodrich, 1922). The numerous taxa found in the Coosa River were generally confined to the lower half of the drainage. These have mostly been extirpated, although a small number may survive in tributaries. *Leptoxis melanoides* was probably endemic to the Black Warrior River of Alabama (Goodrich, 1922), and became extinct most likely as a result of habitat destruction. A probable subspecies of the river snail *Pleurocera verrucosa* from the Little Tennessee River disappeared after the implementation of the TVA hydroelectric schemes, the last dam of which was the controversial Tellico Dam (C. B. Stein, pers. comm.).

Other Gastropod Families

Several Coosa River endemic hydrobiids are now extinct. At least five (but probably more) belonged to the genus *Somatogyrus*. The endemic species *Clappia clappi* is also extinct (Stein, 1976). The genus *Tulotoma* (family Viviparidae) is endemic to the Coosa and Alabama River drainages; if the genus ever inhabited the Tallapoosa River, it was extirpated long ago by siltation (W. J. Clench, pers. comm.). Siltation also caused its disappearance from the Alabama River, and in the Coosa River the genus has been affected by impoundments (Stein, 1976). Living specimens of *T. angulata* were collected at Wetumpka, Alabama, on 1 August 1964 (Patterson, 1964). This discovery is important because Wetumpka is a short distance downstream from the lowermost hydroelectric dam (built in 1928) on the Coosa River. Since it survived downstream from this dam for over 35 years, there is reason for cautious optimism that the species still survives.

The genus *Neoplanorbis*, containing four species and the monotypic genus *Amphigyra* may comprise a subfamily of the freshwater limpets known as the Neoplanorbinae. These extinct forms were confined to swift currents in the lower portion of the main stem of the Coosa River (Stein, 1976). One other extinct Coosa River gastropod is the Coosa scale shell, *Lepyrium showalteri showalteri*, a member of the endemic Alabama family Lepyriidae. The only known habitat of this snail has been destroyed (Stein, 1976).

Unionidae

At least four mussels that were endemic to the Coosa River are extinct: three *Pleurobema*, and one in the genus *Alasmidonta* (Stansbery, 1976). *Alasmidonta mccordi* is known only from the holotype which was collected in 1956 (Athearn, 1964), and the type locality was destroyed by an impoundment in the 1960s (Athearn, pers. comm.).

The freshwater mussel genus *Dysnomia* (= *Epioblasma*) is widely distributed in some of the larger rivers of the Eastern United States. Stream impoundment seems to be the most important factor in the decline of this genus, with pollution and siltation as contributing factors (Stansbery, 1970b). Of the Ohio River basin fauna: "The extinct species were characteristic of the riffle habitats. . . This type of habitat has all but disappeared from the Ohio Basin and is being further reduced by the construction of new and higher dams" (Stansbery, 1970a). The extinction of *Dysnomia lefeverei* of the Black River in Missouri resulted from dredging operations. The recovery pearly mussel *Elliptio nigella* is listed as extinct, its disappearance largely caused by pollution in the form of surface runoff (Opler, 1977, and pers. comm.).

Ecological Effects of Dam Construction

All of the snails mentioned above became extinct because of the effects of hydroelectric dams. As far as the Pleuroceridae of the Coosa River are concerned, "hydroelectrification of the Coosa River, Alabama has caused miles of rapids, the natural habitat of pleurocerids to be covered with deep water" (Goodrich, 1944a; over 90 percent of the 89 endemic Coosa River pleurocerids have met this fate). Rapids interspersed with areas of relatively quiet water in a river provide excellent habitat for snails and mussels (Ortmann, 1924). Flowing water is essential to stream dwelling species because it contains a large amount of dissolved oxygen, keeps the stream bed free of silt and mud, carries away waste materials and organic debris, and aids in reproduction (Stansbery, 1971).

Snails and mussels are important components of stream ecosystems: snails feed on algae; mussels act as cleansing agents by feeding on suspended organic debris, and through formation of beds facilitate the stabilization of river bottoms (Davis, 1977). Both snails and mussels are also food sources for many animals. Mussel larvae (glochidia) are eaten by fish, a vital part in the life cycle of the mussel. The glochidium goes through a parasitic phase within the host fish, encysting within the gills before rupturing and dropping to the river bottom as a juvenile mussel. The host fish presumably derives some nutritional benefit from the mucous enveloping the glochidial masses; and the mussel glochidia receive nutrition, protection against bacterial infection, and a means of dispersal.

Hydroelectric impoundments negatively impact molluscs in a variety of ways. Sunlight is prevented from reaching the river bottom, and as a result the algae upon which the animal depend cannot survive; river flowing into an impoundment deposits sediment, smothering the bottom dwelling life (Stansbery, 1970a). Molluscs are also affected by acidic conditions in the bottom of impoundments, since the acid which results from the decomposition of organic debris dissolves the calcium carbonate of their shells. The relatively stagnant water of impoundments presents yet another problem for mussels because moving water is necessary for the transport of male gametes (Stein, 1971). Although some species can survive behind dams, reproduction often fails to take place. Stansbery (1971) indicated "nearly all of the specimens we obtained from the old channel of the impounded Tennessee River. . . appeared to be healthy and growing, but young specimens were absent. it appeared that no successful reproduction had taken place since impoundment." The operation of hydroelectric facilities also impacts mollusc populations below the dam. The amount of water let out depends upon the quantity of electricity being produced, and at times can be a raging torrent. Areas downstream from dams thereby become clogged with mud and salt coming from the dam water.

Insular Species: The Hawaiian Islands

The Hawaiian Islands harbor one of the most spectacular molluscan faunas in the world, 1061 endemic species having been named (Hart, 1975), with many more still to be described (Solem, pers. comm.). The high degree of localization in many species of Hawaiian tree snails has made them especially vulnerable to extinction.

In the land snail genus *Carelia* (a member of the endemic family Amastridae), twelve species and subspecies are known only from subfossil remains, while seventeen survived up until recent times (Cooke, 1931; Hart, 1976). *Carelia* was last collected alive in 1945-1947 (Arnemann, pers. comm.), and the genus is considered to be extinct today (Solem, pers. comm.). With the exception of one form from Niihau, all of the species of *Carelia* were endemic to the island of Kaui. There is a possibility that the genus was dying out naturally at the time of its discovery, but introduced cattle and pigs have probably been the main causes of its demise—cattle destroyed forests by trampling the vegetation, while pigs ate the snails. The destruction of forests for agriculture has also had an adverse impact on *Carelia* (Kondo, pers. comm.). Kondo has also documented the extinction of the genera *Pterodiscus, Planamstra,* and *Leptachatina*. Additionally, only 30 of the 200 living or recently extinct endemic species of the family Endodontidae have been described. The exact causes of the extinction of these animals are unknown, but deforestation, introduced mammals and carnivorous snails, and dilution of habitat have all been implicated in the extirpation of native Hawaiian land snails. Introduced ants have also had a severe impact on ground-dwelling snails below 2000 feet elevation on all the main islands.

Approximately 20 of the 41 species in the endemic Oahu genus *Achatinella* are now extinct, and the few thriving colonies of this genus of tree snails will probably soon be extirpated (Hart, 1978a; see the Red Data Book [IUCN, 1983] writeup on this group). The factors involved in the decline of this genus are numerous. Overcollection of these animals for their beautiful shells caused the initial decline in the population size (Hart, 1978a). The effects of introduced animals have also been severe. More than 90 years ago, Baldwin (1887) noted that introduced cattle, mice, and rats were taking a toll on *Achatinella*. Hart (1978a) adds that pigs, sheep, and goats have adversely affected these snails by destroying vegetation. But the introduced carnivorous snail *Euglandina rosea* has had the greatest impact of any introduced animal. It has been estimated that one third of the *Achatinella* known to have existed in the last 20 years have succumbed to *Euglandina* predation (Hart, 1975). Biological pollution of native forests by introduced plants has also had adverse effects, as *Achatinella* has adapted to only a small number of these exotics. Another factor has been habitat loss from fires, commercial logging (in the 19th century), military activities, and particularly agricultural operations (Hart, 1978b).

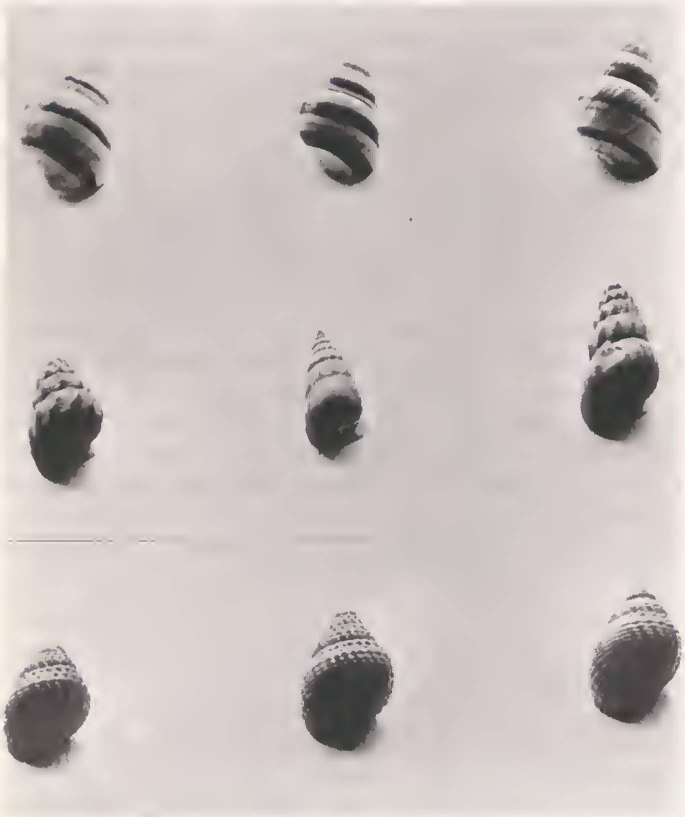

Figure 2. Representative molluscan taxa: top, *Achatinella*; middle, *Goniobasis*; bottom, *Leptoxis*. See text for discussion of status.

Spring and Pond Species

Several species of molluscs confined to small spring and/or pond habitats scattered throughout the United States have become extinct. Among species in the family Hydrobiidae, *Amnicola neomexicana* was restricted to a thermal area near the Socorro Mountains in New Mexico. The original habitat of this snail has been destroyed because the springs are now intercepted at the surface, with the water being piped off to other areas; it may be extinct. The extinction of *Fontelicella* sp. from a single spring on the Manse Ranch in the Pahrump Valley, Nevada, is probably traceable to the fact that its spring habitat dried up in 1975 as a result of excessive ground-water pumping (Landye, pers. comm.). The Fish Springs pond snail *Stagnicola pilsbryi* of southwestern Utah may have been exterminated when its wetland habitat was burned for waterfowl management (Bickel, 1977); the US Fish and Wildlife Service has recently contracted a survey for this snail. The specific causes of the loss of the Utah pond snail *Stagnicola utahensis* are unknown, but lowered lake levels due to both natural and human-influenced causes, and the alteration of shoreline springs were doubtless important factors (Bickel, 1977). The extinction of *Marstonia olivacea* from Big Spring Creek in Huntsville, Alabama, is presumably due to the fact that the limited habitat of this snail has been destroyed by stream channelization and pollution (Thompson, 1975).

The Greenfield ramshorn snail *Helisoma magnifica* of the family Planorbidae is endemic to Greenfield Pond, North Carolina (Fuller, 1977). It is unclear whether this species still survives; eggs were found several years ago (Morrison, pers. comm.). *H. magnifica* is thought to have gone extinct when the water level of Greenfield pond was decreased twenty feet in order to kill off aquatic vegetation, thus causing the snails to freeze to death during the winter (Imlay, 1977). The factors which caused the loss of another Greenfield Pond endemic, the Cape Fear ramshorn snail *Taphius eucosmius*, have not yet been ascertained (Fuller, 1977).

Conclusions

Habitat destruction has been a factor in nearly every extinction discussed in this paper, and in many cases it was the only cause. Hydroelectric dams and pollution have had a particularly severe impact on riverine taxa, and, as Stansbery (1977) indicated, “we are left with the inescapable conclusion that we are gradually destroying nearly a thousand endemic species of freshwater molluscs. This fauna. . . is in the process of being eliminated in only a century or two.” The spectacular insular Hawaiian fauna is suffering a similar reduction due in large part to parallel habitat loss.

Virtually all the extinct molluscs of the United States were geographically localized to some extent. The degree of localization varied considerably among species, but even those which were confined to fairly large sections of a single drainage system had restricted enough ranges for one threat to have been sufficient to destroy the species. Many species have probably become extinct prior to their even being known to science, and extinctions among undescribed taxa will continue to occur as long as unique habitats are destroyed. If some remnants of our great molluscan fauna are to be preserved, action must be taken rapidly to remove the threats outlined above. If not, some of the most spectacular molluscan faunas in the world will be lost forever.

Acknowledgments

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Table 1. List of presumed extinct molluscs in the United States. Last collection date and/or extinction date appended to specific name when known. Asterisk = personal communication. Range key: Coosa River = CR; Chattahoochee River = ChR; Black Warrior River = BWR; Coosa-Alabama Rivers = C-AR; Tennessee River = TR; Ohio River = OR; Black River, AK = BR;AK; Wabash River = WR; Apalchicola River = AR; Oahu, Hawaii = OH; Kaui, Hawaii = KH; Hawaii = HA; New Mexico = NM; Nevada = NV; North Carolina = NC; Alabama = AL; Utah = UT.

Species	Authority	Range
Apella alabamensis	Stein (1976)	CR
Apella ampla-1914	Stein (1976)	CR
Apella carinifera-1914	Stein (1976)	CR
Apella excisa-1928	Stein (1976)	CR
Apella hendersoni-1914	Stein (1976)	CR
Apella incisa-1928	Stein (1976)	CR
Apella laciniata-1928	Stein (1976)	CR
Apella lewisi-1914	Stein (1976)	CR
Apella pagoda-1928	Stein (1976)	CR
Apella pumila-1928	Stein (1976)	CR
Apella pyramidata-1964	Stein (1976)	CR
Apella spillmani-1964	Stein (1976)	CR
Apella walkeri-1923	Stein (1976)	CR
Goniobasis alabamensis-1964	Stein (1976)	CR
Goniobasis bellula-1964	Stein (1976)	CR
Goniobasis boykiniana	Stein (1976)	ChR
Goniobasis brevis	Stein (1976)	CR
Goniobasis catenoides-1800's	Stein (1976)	ChR
Goniobasis clausa-1964	Stein (1976)	CR
Goniobasis crenatella-1966	Stein (1976)	CR
Goniobasis fallax	Stein (1976)	CR
Goniobasis fascinans-1966	Stein (1976)	CR
Goniobasis furva	Stein (1976)	CR
Goniobasis fusiformis	Stein (1976)	CR
Goniobasis gibbera-1964	Stein (1976)	CR
Goniobasis hartmanianum-1966	Stein (1976)	CR
Goniobasis haysiana-1923	Stein (1976)	CR
Goniobasis impressa-1964	Stein (1976)	CR
Goniobasis jonesi-1964	Stein (1976)	CR
Goniobasis lachryma-1966	Stein (1976)	CR
Goniobasis laeta-1966	Stein (1976)	CR
Goniobasis macglameriana-1966	Stein (1976)	CR
Goniobasis osculata	Stein (1976)	CR
Goniobasis pilsbryi-1964	Stein (1976)	CR
Goniobasis pupaeformis-1964	Stein (1976)	CR
Goniobasis pygmaea-1914	Stein (1976)	CR
Goniobasis vanuxemia-1966	Stein (1976)	CR
Leptoxis aldrichi-1914 or 1923	Stein (1976)	CR
Leptoxis brevispira-1914	Stein (1976)	CR
Leptoxis clipeata-1964	Stein (1976)	CR
Leptoxis coosaensis-1914	Stein (1976)	CR
Leptoxis flexuosa-1923	Stein (1976)	CR
Leptoxis formani-1923	Stein (1976)	CR
Leptoxis griffithiana-1928	Stein (1976)	CR
Leptoxis ligata-1928	Stein (1976)	CR
Leptoxis lirata-1914	Stein (1976)	CR
Leptoxis melanoides	Stein (1976)	BWR
Leptoxis occulata-1923	Stein (1976)	CR
Leptoxis showalteri	Stein (1976)	CR
Leptoxis sulcata-1964 or 1966	Stein (1976)	CR
Leptoxis torrefacta-1914	Stein (1976)	CR
Leptoxis vittata-1928	Stein (1976)	CR
Somatogyrus constrictus-1928	Stein (1976)	CR
Somatogyrus crassus-1928	Stein (1976)	CR
Somatogyrus hendersoni-1923	Stein (1976)	CR
Somatogyrus pygmaeus-1914	Stein (1976)	CR
Neoplanorbis carinatus-1923	Stein (1976)	CR
Neoplanorbis smithi-1923	Stein (1976)	CR
Neoplanorbis tantillus-1923	Stein (1976)	CR
Neoplanorbis umbilicatus-1923	Stein (1976)	CR
Tulotoma angulata	Davis (1974)	CR
Tulotoma coosaensis	Davis (1974)	CR
Tulotoma magnifica	Davis (1974)	C-AR
Amphigyra alabamensis-1914	Stein (1976)	CR
Clappia clappi-1923	Stein (1976)	CR
Lepyrium showalteri showalteri	Stein (1976)	CR
Pleurocera verrucosa ssp.	Stein (1980)	TR
Achatinella abbreviata	Hart (1978a)	OH
Achatinella buddi	Hart (1978a)	OH
Achatinella caesa	Hart (1978a)	OH
Achatinella cestus	Hart (1978a)	OH
Achatinella decora	Hart (1978a)	OH
Achatinella dimorpha	Hart (1978a)	OH
Achatinella elegans	Hart (1978a)	OH
Achatinella juddi	Hart (1978a)	OH
Achatinella juncea	Hart (1978a)	OH
Achatinella lehuiensis	Hart (1978a)	OH
Achatinella livida	Hart (1978a)	OH
Achatinella papyracea	Hart (1978a)	OH
Achatinella phaezona	Hart (1978a)	OH
Achatinella rosea-1960's	Hart (1978a)	OH
Achatinella spaldingi	Hart (1978a)	OH
Achatinella stewartii	Hart (1978a)	OH
Achatinella thaanumi	Hart (1978a)	OH
Achatinella valida	Hart (1978a)	OH
Achatinella viridans	Hart (1978a)	OH
Achatinella vittata	Hart (1978a)	OH
Achatinella vulpina	Hart (1978a)	OH
Carelia anceophila	Cooke (1931)	KH
Carelia bicolor-1945/47	Hart (1976)	KH
Carelia bicolor angulata	Hart (1976)	KH
Carelia cummingiana	Opler (1977)	KH
C. c. meinecki	Hart (1976)	KH
Carelia glossema	Opler (1977)	KH
Carelia hyattiana	Cooke (1931)	KH
C. kalalauensis-1945/47	Opler (1977)	KH
Carelia knudseni	Cooke (1931)	KH
Carelia olivacea	Opler (1977)	KH
C. o. baldwini	Hart (1976)	KH
C. o. priggeyi	Cooke (1931)	KH
C. o. propinquella	Hart (1976)	KH
Carelia paradoxa	Cooke (1931)	KH
Carelia periscellis	Cooke (1931)	KH
Carelia tenebrosa	Opler (1977)	KH
Carelia turricula	Opler (1977)	KH
genus *Leptachatina*	Kondo*	HA
genus *Planamastra*	Kondo*	HA
genus *Pterodiscus*	Kondo*	HA
Amnicola neomexicana-1971	Opler (1977)	NM
Fontelicella n. sp.-1975	Landye*	NV
Helisoma magnifica-1947	Opler (1977)	NC
Marstonia olivacea	Thompson (1975)	AL
Stagnicola pilsbryi	Bickel (1977)	UT
Stagnicola utahensis	Bickel (1977)	UT
Taphius eucosmius eucosmius	Fuller (1977)	NC
Mussels:		
Dysnomia arcaeformis-1940's	Opler (1977)	TR
Dysnomia biemarginata	Stansbery (1970b)	TR

Dysnomia cincinnatiensis	Stansbery*	OR
Dysnomia flexuosa-1940's	Opler (1977)	TR
Dysnomia florentina	Stansbery (1976)	TR
Dysnomia lefevrei	Buchanan*	BR,AK
Dysnomia lenoir-1965	Opler (1977)	TR
Dysnomia lewisi-1940's	Opler (1977)	TR
Dysnomia personata-1800's	Opler (1977)	OR
Dysnomia propinqua-1910's	Opler (1977)	TR
Dysnomia sampsoni-1910's	Opler (1977)	WR
Dysnomia steardsoni-1910's	Opler (1977)	TR
Dysnomia turgidula	Imlay (1977)	TR
Elliptio nigella-1954	Opler (1977)	AR
Alasmidonta mccordi-1964 *or* 1966	Athearn*	CR
Pleurobema hartmanianum	Athearn*	CR
Pleurobema nucleopsis	Stansbery (1976)	CR
Pleurobema showalteri	Stansbery (1976)	CR

Correction

In John Lane's article on Alta California monarch overwintering sites, published in *Atala* Vol. 9, line 2 of paragraph 2 on page 17 should read "until the early 1880s" (cf. "1800s").

Thoughts on Providing Nectar Sources for some North American Butterflies

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Introduction

There now appears to be no doubt as to the need and ecological value of well planned butterfly gardening, especially in areas of diminishing natural habitat. Nor is there any doubt as to the value of butterfly gardening as a medium for encouraging the conservation ethic (Heal, 1973; Pyle, 1974; Jackson, 1979b and 1981). The increased interest in butterfly gardening and the proliferation of articles on the subject in the popular press indicates a need for more detailed information on various aspects of this topic, not least of which is the potential of ornamental plants as nectar sources.

For the past twelve years I have been growing potential nectar sources and observing the relationship between these plants and native butterflies. My study area has been the Oxen Pond Botanic Park (47° 34′N. 52° 43′W) situated near St. John's, the capital city of Newfoundland and Labrador, Canada.

In comparison to some areas of more favourable geographical positioning and climatic conditions, Newfoundland suffers a paucity of butterflies both in numbers of species and individuals making up the various populations. Fifty species have been recorded from insular Newfoundland (Morris, 1980; Jackson, 1981b). Two of these are doubtful records (Morris, 1980) whilst at least another twenty are either uncommon or decidedly rare.

During the twelve years of investigation, twenty six species have been recorded from the study area (Table 1). Amongst butterflies attracted to the Parks semiformal flower beds three new provincial records have been established (Jackson, 1981b).

Not all these twenty six species have been attracted to exotic flora. The Jutta Arctic, Bog Copper and Northern Blue, although resident in the Park, have not been recorded nectaring on exotics. The Pearl Crescent, Clouded Sulphur and Hop Merchant have been recorded in the study area only once. If in abundance these butterflies would I think be attracted to garden ornamentals. The White Admiral has only recently (1982) moved into the general area. I believe that this species can be attracted to garden flowers if it is present in sufficient numbers. The spectacular Monarch has only been observed in the Park on three occasions but it nevertheless utilized exotic nectar sources.

Methods

Since some butterflies use suitable flower heads for "sunning," records were only made of flowers where the butterfly was seen to be probing persistently with its proboscis. If a butterfly was observed nectaring, then the species of both the flower and the butterfly were recorded but neither the number of visitations nor the length of nectaring time spent on each plant was recorded.

Eighty two species of exotic flora belonging to sixty two genera have been found to attract one or more of the twenty six species of butterfly visiting the Park (Table 2). Data on the European Cabbage Butterfly (*Pieris rapae* L.) have not been recorded.

These non-native ornamental plants were chosen for trial by one or more of the following methods: (a) reading of their value for this purpose in the literature (Newman, et al. 1967), (b) by checking for exotic plants in the same genus as known indigenous plants of value (Kulman, 1977), (c) by checking the literature (Genders, et al. 1978) for highly scented flora, (d) by personal observation elsewhere and by communication between other enthusiasts. I would suggest that this procedure be adopted by any new aspiring butterfly gardener.

When it is believed that a potentially suitable plant has been discovered, a decision whether or not to try to grow it must then be made. Many known, highly successful butterfly attractants cannot be grown in the study area. Oxen Pond Botanic Park lies in the Horticultural Plant Zone 5B (6. U.S.A.) so that the use of many a valuable but somewhat delicate genera, for instance Milkweed (*Asclepias* sp) or *Hebe* sp, has to be foregone.

Table 1. Butterflies recorded in the Oxen Pond Botanic Park (left and center), showing the total number of flower species visited by each butterfly among the 82 exotic plants found to attract one or more butterflies (right). An * indicates butterfly species sighted in Park on only one occasion; an ** indicates butterfly species not usually seen in the area of the ornamental flower beds.

Short Tailed Swallowtail	*Papilio brevicauda* Saund.	6
Canadian Tiger Swallowtail	*P. glaucus canadensis* R. & J.	13
Common or Clouded Sulphur *	*Colias philodice* Godt.	2
Pink-edged Sulphur **	*C. interior* Scud.	1
European Cabbage Butterfly	*Pieris rapae* L.	0
Monarch	*Danaus plexippus* L.	2
Inornate Ringlet	*Coenonympha inornata* Edw.	0
McIsaac's Ringlet	*C. i. mcisaaci* dos P.	2
Jutta Arctic **	*Oeneis jutta terrae novae* dos P.	0
Atlantis Fritillary **	*Speyeria atlantis* Edw.	1
Pearl Crescent *	*Phyciodes tharos arctica* dos P.	0
Green Comma	*Polygonia faunus* Edw.	8
Hop Merchant *	*P. comma* Harris	0
Compton's Tortoise Shell	*Nymphalis vau-album* D. & S.	4
Milbert's Tortoise Shell	*N. milberti viola* dos P.	28
Mourning Cloak	*N. antiopa* L.	10
Red Admiral	*Vanessa atalanta* L.	48
American Painted Lady	*V. virginiensis* Dru.	7
Painted Lady	*V. cardui* L.	25
White Admiral	*Limenitis arthemis* Dru.	2
Brown Elfin	*Callophrys augustinus* West.	2
Bog Copper **	*Lycaena epixanthe phaedura* Hall	0
Northern Blue **	*Plebejus argyrognomon aster* Edw.	0
Spring Azure	*Celastrina argiolus pseudargiolus* B. & LeC.	6
Arctic Skipper **	*Carterocephalus palae non* Pall.	2
European Skipper	*Thymelicus lineola* Ochs.	5

Table 2. Flowers (left and center) and number of butterfly species that visit them (right). Flower prefixes: a = annual; b = biennial; p = perennial; s = shrub.

a Floss Flower	*Ageratum houstonianum* "blue mink"	4
a Pot Marigold	*Calendula officinalis*	2
a Cladanthus	*Cladanthus arabicus*	1
a Cosmos	*Cosmos* hybrids	4
a Chinese Forget-me-not	*Cynoglossum amabile*	4
a Sweet William	*Dianthus barbatus* "wee willie"	5
a Echium	*Echium vulgare* hybrids	3
a Straw Flower	*Helichrysum bracteatum*	5
a Candy Tuft	*Iberis umbellata*	5
a Poached Egg	*Limnanthes douglasii*	1
a Star Phlox	*Phlox drummondii cuspidata*	1
a Cone Flower	*Rudbeckia* vars.	4
a Pin Cushion Flower	*Scabiosa atropurpurea*	3
a French Marigold	*Tagetes patula* "naughty marrieta"	8
a Verbena	*Verbena hortensis*	1
b Siberian Wallflower	*Cheiranthus allionii*	4
b Sweet William	*Dianthus barbatus*	2
b Swe ket	*Hesperis matronalis*	2
b Forget-me-not	*Miotis scorpioides*	2
b Sweet William Catchfly	*Silene armeria*	1
p Yarrow	*Achillea ptarmica* "the pearl"	1
p Monkshood	*Aconitum napellus*	1
p Monkshood	*A. bicolor*	1
p Chives	*Allium schoenoprasum*	6
p Basket-of-gold	*Alyssum saxatile*	1
p Chamomile (Ox-eye)	*Anthemis tinctoria*	1
p Rock Cress	*Arabis alpina*	4
p Thrift	*Armeria maritima*	1
p Michaelmas Daisy	*Aster novae-belgii* vars.	4
p Astilbe	*Astilbe X arendsii*	1
p Astilbe	*A. X crispa* "perkeo"	1
p Carpathian Harebell	*Campanula carpatica*	1
p Perennial Cornflower	*Centaurea montana*	1
p Shasta Daisy (single)	*Chrysanthemum maximum*	4
p Tickseed	*Coreopsis grandiflora* "baby sun"	1
p Dutchmans Breeches	*Dicentra formosa*	3
p Bleeding Heart	*D. spectabilis*	1
p Leopards Bane	*Doronicum plantagineum*	1
p Globe Thistle	*Echinops ritro*	2
p Sea Holly	*Eryngium planum*	2
p Coral Bells (yellow)	*Heuchera racemosa*	1
p Candy Tuft	*Iberis sempervirens*	1
p Dwarf Candy Tuft	*I. saxatilis*	1
p Sheperds Scabius	*Jasione perennis*	1
p Pretty Betsy	*Kentranthus ruber*	1
p Edelweiss	*Leontopodium alpinum*	1
p Gayfeather (purple)	*Liatris spicata*	3
p Purple Loosestrife	*Lythrum salicaria*	2
p Catnip	*Nepeta macrantha*	1
p Dwarf Phlox	*Phlox douglasii*	3
p Fall Phlox	*P. paniculata*	5
p Moss Phlox	*P. subulata*	3
p Jacobs Ladder	*Polemonium caeruleum*	2
p Golden Glow	*Rudbeckia laciniata hortensis*	1
p Gloriosa Daisy	*R. tetra gloriosa*	2
p Soapwort	*Saponaria ocymoides*	1
p Bouncing Bett	*S. officinalis flora plena*	5
p Pincushion Flower	*Scabiosa caucasica* "house hybrids"	2
p Pincushion Flower	*S. lucida*	2
p Showy Sedum	*Sedum spectabile*	6
p Stonecrop	*S. spurium*	2
p Orpine	*S. telephium*	1
p Spiraea	*Spiraea digitata nana*	2
p Devilsbit Scabius	*Succisa pratensis*	3
p Tansey	*Tanacetum vulgare*	1
p Creeping Thyme	*Thymus* sp.	1
p Globe Flower	*Trollius chinensis*	1
p Valerian	*Valeriana officinalis*	2
p Valerian	*V. arizonica*	2
p Veronica	*Veronica repens*	1
p Veronica	*V. spicata*	1
p Veronica	*V. teucrium*	1
p Violet	*Viola* sp.	2
s Butterfly Bush	*Buddleia davidii*	6
s Scottish Heather	*Calluna vulgaris*	1
s Cotoneaster	*Cotoneaster adpressa*	1
s Spring Heath	*Erica carnea* "king george"	3
s Spring Heath	*E.* "cherry stevens"	1
s Common Privet	*Ligustrum vulgare*	1
s Crabapple	*Malus* "makamik"	1
s Bridlewreath	*Spiraea X vanhouttie*	1
s Common Lilac	*Syringa vulgaris*	1

Table 3. Frequency of visitation (expressed as number of different butterfly species visiting) to each of the 82 exotic plants in the Park.

# Butterflies.	1	2	3	4	5	6	7	8
# Plants	41	17	8	8	4	3	0	1
%	50.6	19.7	9.8	9.8	4.9	3.7	0	1.2

L
41
185
.13
0.1
46

Table 6. Some flowers that have been grown for butterflies, but that have not yet proven attractive to them in the vicinity of St. John's. Flower prefixes: a = annual; p = herbaceous perennial.

a Sweet Alyssum	*Alyssum maritimum* vars.
a Love-lies-bleeding	*Ameranthus caudatus*
a Snapdragon	*Antirrhinum* vars.
a Aster	*Aster pepito*
a Swan River Daisy	*Brachycome* "purple splendour"
a China Aster	*Callistephus chinensis*
a Cockscomb	*Celosia argentea*
a Cockscomb	*Celosia cristata*
a Cornflower	*Centaurea cyanus*
a Sweet Sultan	*C. moschata*
a Clarkia	*Calrkia elegans*
a Cynoglossum	*Cynoglossum* sp.
a Dianthus	*Dianthus sinensis* "sweet wivelsfield"
a Satin Flower	*Godetia grandiflora*
a Gomphrena	*Gomphrena globosa*
a Sunflower	*Helianthus annuus*
a Impatiens	*Impatiens glandulifera*
a Sweet Pea	*Lathyrus odoratus*
a Edging Lobelia	*Lobelia erinus*
a Night Scented stock	*Mathiola bicornis*
a Ten Weeks stock	*M. incana annua*
a Four-o-Clock	*Mirabilis jalapa*
a Flowering Tobacco	*Nicotiana alata grandiflora*
a Love-in-a-mist	*Nigella damascena*
a Petunia	*Petunia* vars.
a Mignonette	*Reseda odorata* vars.
a Scarlet Sage	*Salvia splendens*
a Sea Lavender	*Statice sinuata*
a French Marigold	*Tagetes patula* vars.
a Nasturtium	*Tropaeolum majus*
a Verbena	*Verbena* vars.
a Immortelle	*Xeranthemum annuum*
a Zinnia	*Zinnia* vars.
p Yellow Yarrow	*Achillea filipendulina* "coronation gold"
p Bugle	*Ajuga reptans*
p Columbine	*Aquilegia* sp.
p Goatsbeard	*Aruncus sylvester*
p Giant Rockfoil	*Bergenia cordifolia*
p Bluebells	*Campanula rapunculoides*
p Bluebells	*C. glomerata*
p Bluebells	*C. persicifolia*
p Yellow Knapweed	*Centaurea macrocephala*
p Lily-of-the-valley	*Convallaria majalis*
p Delphinium	*Delphinium* spp.
p Cottage Pink	*Dianthus plumarius*
p Gas Plant	*Dictamnus albus*
p Fleabane	*Erigeron aurantiacus*
p Queen-of-the-prairie	*Filipendula rubra* "magnifica"
p Pride-of-the-meadow	*F. ulmaria*
p Craneshill	*Geranium* spp.
p Avens	*Geum chiloense*
p Sneezeweed	*Helenium autumnale*
p Day Lily	*Hemerocallis* sp.
p Bearded Iris	*Iris* sp.
p Red Hot Poker	*Kniphofia galpinii*
p Everlasting Pea	*Lathyrus latifolius*
p Lily	*Lilium martagon*
p Lily	*L. tigrinum*
p Lily	*L. aurantiacum*
p Lupine	*Lupinus* spp.
p Maltese Cross	*Lychnis chalcedonica*
p Yellow Loosestrife	*Lysimachia punctata*
p Musk Mallow	*Malva moschata*
p Welsh Poppy	*Meconopsis cambrica*
p Beebalm	*Monarda didyma*
p Peony	*Paeonia* spp.
p Oriental Poppy	*Papaver orientale*
p False Dragonhead	*Physostegia virginiana*
p Balloonflower	*Playcodon grandiflorum*
p Solomons Seal	*Polyonatum multiflorum*
p Lungwort	*Pulmonaria saccharata*
p Lungwort	*P. angustifolia*
p Painted Daisy	*Pyrethrum* sp.
p Sage	*Salvia superba*
p Wild Hollyhock	*Sidalcea spicata*
p Betony	*Stachys lanata*
p Betony	*S. macrantha*
p Globe Flower	*Trollius ledebourii*
p Mullein	*Verbascum phoeniceum*

Table 5. Number of flowers (exotic, indigenous and naturalized) visited by eight different butterfly species, indicating the various colors involved and the resultant possible color preferences.

	# Flowers utilized	# Flower colours	of Yellow		of Blue		of Purple		of Red		of Pink		of White		of Orange	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%
Short Tailed Swallowtail Papilio brevicauda Saund.	16	6	6	38	1	6	1	6	1	6	4	25	3	19	-	-
Tiger Swallowtail Papilio glaucus canadensis R & J	12	6	3	25	3	25	2	17	-	-	2	17	1	8	1	8
Milbert's Tortoise Shell Nymphalis milberti viola dos P.	31	7	5	16	7	23	4	13	1	3	5	16	7	23	2	6
Red Admiral Vanessa alalanta L.	52	7	10	19	13	25	6	12	1	2	14	27	7	13	1	2
Painted Lady Vanessa cardui L.	33	7	5	16	11	34	4	12	1	3	8	25	3	9	1	3
American Painted Lady Vanessa virginiensis Dru	10	4	3	30	-	-	4	40	-	-	2	20	1	10	-	-
Mourning Cloak Nymphalis antiopa L	11	5	2	18	-	-	3	27	1	9	2	18	3	27	-	-
Green Comma Polygonia faunus Edw	13	5	3	23	2	15	2	15	-	-	4	31	2	15	-	-

Table 4. Flowers that have been recorded attracting five or more species of butterflies, either inside or outside the Park boundaries.

	Papilio brevicauda Saund.	P. glaucus candensis R. & J.	Colias interior Scud.	Danaus plexippus L.	Coenonympha inornata mcisaaci dos p.	Oeneis jutta terraenovae dos p.	Speyeria atlantis Edw.	Boloria selene terraenovae Holland	Phyciodes tharos arctica dos P.	Polygonia faunus Edw.	P. comma Harris	Nymphalis vau-album D. & S.	N. milberti viola dos P.	N. antiopa L.	Vanessa atalanta L.	V. virginiensis Dru.	V. cardui L.	Limenitis arthemis Dru.	Lycaena expixanthe phaedrus Hall.	Plebejus argyrognomon aster Edw. Lycaena	P. aquilo Boisduval	Celastrina argiolus pseudargiolus B & LeC	Carterocephalus palaemon Pall.	Thymelicus lineola Ochsenheimer.	# butterflies visiting individual flower species
Exotic:-																									
Tagetes patula "Naughty Marrietta".	X		X				X						X	X	X	X	X								8
Helichrysum bracteatum.												X	X	X	X		X								5
Dianthus barbatus "Wee Willie".	X				X					X					X									X	5
Saponaria officinalis.										X		X	X	X	X										5
Phlox paniculata										X		X		X	X	X									5
Allium schoenoprasum.	X	X											X		X		X						X		6
Buddleia davidii.				X									X	X	X	X	X								6
Sedum spectabile.										X			X	X	X	X	X								6
Indigenous or naturalized:-																									
Ledum groenlandicum.	X				X	X											X				X				5
Taraxacum officinale.	X	X								X	X				X		X					X			7
Anaphalis margaritacea.			X				X	X					X	X	X			X	X	X				X	10
Trifolium pratense.		X	X	X										X		X	X							X	7
Solidago graminifolia.				X						X		X	X	X	X	X	X	X						X	10
Eupatorium maculatum.							X	X		X			X		X		X		X	X					8
Centaurea nigra.				X			X			X			X		X	X	X							X	8
Chrysanthemum leucathemum.					X		X		X				X										X	X	6
Archillea millefolium.							X					X	X		X	X	X								6
Cirsium arvense.										X			X		X		X	X						X	6
# flowers visited by individual butterfly species.	5	3	3	4	3	1	6	2	1	9	1	5	13	9	15	8	13	3	2	2	1	1	2	7	

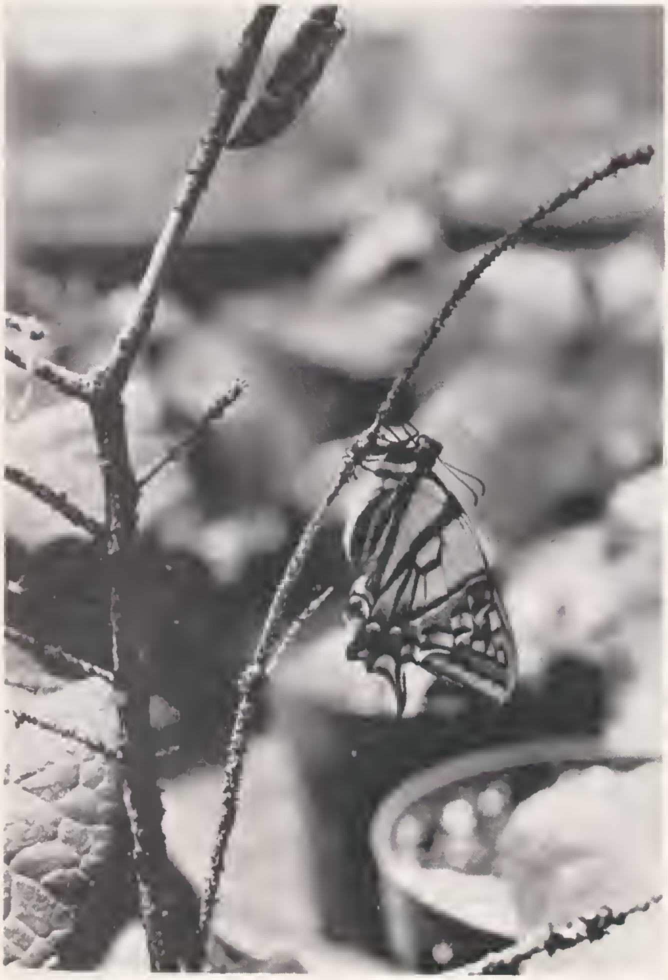

Figure 1. Canadian Tiger Swallowtail (*Papilio glaucus canadensis*) and a chrysalis. Hand reared from collected egg.

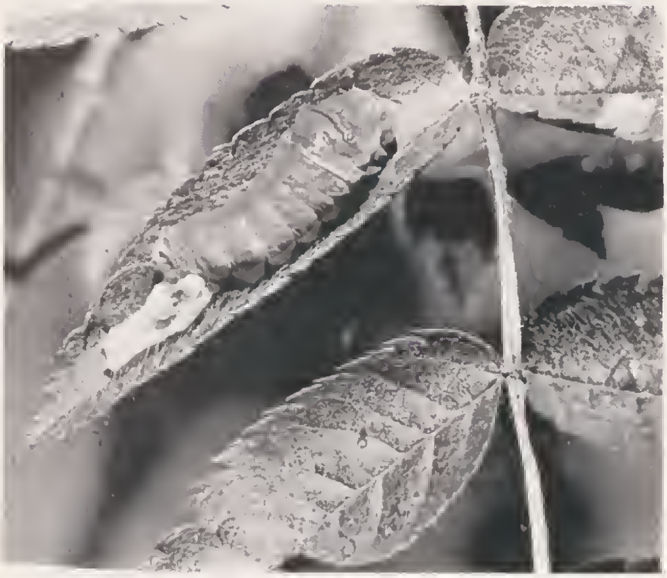

Figure 2. Caterpillar of Canadian Tiger Swallowtail (*Papilio glaucus canadensis*) sloughing skin. Hostplant American Mountain Ash (*Sorbus americana*). Hand reared from collected egg.

The famous Butterfly Bush (*Buddleia davidii*) can sometimes be overwintered successfully in my area but often does not start into growth early enough in the season to ensure flowering. The pink and white Valerian (*Centranthus ruber*) with its unpleasant smell of perspiration (Genders, 1978), and so beloved by certain British butterflies, is also difficult to produce and moreover, is inclined to bloom when insufficient butterflies are on the wing.

Observations and Discussion

Fourty one out of my eighty two exotic nectar sources have only attracted one species of butterfly and seventeen of the eighty two, only two species (Table 3). In a small garden where space is at a premium and every plant species must pull its weight, many of these plants could be dispensed with. However, one must be very sure of which species of butterfly it is desirous of attracting, before deciding which flowers to scrap. Many such flowers only attract the Red Admiral and since there are numerous, more irresistible plants for this species, it would not matter to disregard some of them. However, for me to discard the rock garden Soapwort (*Saponaria ocymoides*) whose only visitor has been the Arctic Skipper, or the Creeping Veronica (*Veronica repens*) which is one of only two exotics that has attracted our Brown elfin, would be folly.

You will notice (Table 4) that Bouncing Bet is ranked as one of my exotic flowers that attract five different species of butterfly. This actually gives a false impression of its value, for butterflies only make fleeting visits to it. We only have the double flowered variety (*Saponaria officinalis* var rosea-plena) however, and since butterflies on the whole do not favour double blooms, it may be a different story were we to grow the plant in its species form.

Of the butterflies that have been attracted to one or more of the provided exotic nectar sources, the Red Admiral, Painted Lady and Milbert's Tortoise Shell appear the most catholic in their taste (Table 4).

In my area the Red Admiral is by far the easiest butterfly to attract and the most ready to respond to management techniques. In 1981, the year of the Red Admiral in my area, I counted 197 around the flowerbeds on one occasion and on another, 130 on our perennial border alone! A friend counted thirty on a two foot square patch of Michaelmas Daisy (*Aster* sp) (Clase, pers. comm.).

Exotic flowers that provide a source of nectar early in the season are particularly important to the butterfly gardener. These are far more difficult to locate than those that do so later on in the summer—hence the value of the common Dandelion! In the Park the only early blooming exotics of any note are the Rock-cress (*Arabis alpina* vars) and *Erica carnea*, "King George". The latter also appears to be the mainstay of the local queen bumblebees recently emerged from hibernation. It is on a clump of this plant that I usually record the first bumblebee for the season, around May 15th.

Of course, whether a nectar source, either native or exotic, is of any value depends largely on its positioning in the garden. They are more favoured in a sheltered location and must be in the sunshine, preferably all day but at least part of the day between mid-morning and late afternoon. Unless the area is very small it is best to locate the plants along obstacles such as fences, hedgerows or at the gaps between buildings or blocks of trees. Garden butterflies are inclined to move along these flight lines.

The flowering period of the plant has to be right, for no matter how much nectar it can produce, it is of little value if suitable butterflies are not on the wing at this time, or for this matter, are so thinly populated over the area that they have little chance of locating it. Choosing plants whose flowering season are properly synchronized with butterfly flight periods is vital to success.

The value of a nectar source is to some extent governed by the quantity and quality of other available supplies. Butterflies with a large expanse and variety of suitable blooms at their disposal seldom gather en masse at one source, unless of course that source is a particularly good attractant amongst a host of much lesser ones.

When considering possible exotic nectar sources for landscaping one of the basic rules is to try to pick single bloomed, old fashioned flowers (Newman, 1967; Jackson, 1977). Many of the modern cultivars, though beautiful in themselves, are worthless as nectar sources for butterflies.

The actual size of the flower may be important to some species (Proctor and Yeo, 1973). So may the formation of the flowers on the stem. Though butterflies will work suitable flower spikes (e.g. Red Admiral on *Veronica spicata*), they nevertheless seem to have a greater affinity for umbellate flowers or those, such as the composite flowers, that provide a disk on which to settle. The size of the flower clump is, I think, also important—especially so if it stands alone or is surrounded by purely leafy vegetation as in many modern horticultural landscapes of shrubs, foliage plants and evergreen groundcovers. The larger the clump the stronger the scent emitted and the greater flash of colour to perceive. Butterflies cannot see great distances so it may be that their initial location of the nectar source is by smell. Working with the Peacock butterfly (*Nymphalis io*) in Britain, Lederer (1951) found that this butterfly could detect a scent from distances ranging from 20 cm to 30 m, or with a favourable wind, from 60 m (Proctor and Yeo, 1973). It would appear that locating the nectar source by sight may come to the fore once the butterfly has arrived in the correct general area.

Flowers that attract butterflies are often those that possess a heavy, sweet fragrance. Good examples are *Buddleia*, lance-leaved goldenrod, wallflower and pinks (*Dianthus* sp). It has been suggested that the carnation scent, found in various species of *Dianthus*, is widespread in butterfly and moth pollinated flowers (Proctor and Yeo, 1973).

Figure 3. White Admiral (*Limenitis arthemis*) just emerged from Chrysalis. Hand reared from collected egg. Hostplant Chuckly Pear (*Amelanchier bartramiana*).

Colour also seems to influence a butterfly's acceptance of a flower and it appears that not all butterflies have the same range of colour vision (Ford, 1946). Human eyesight perceives colour differently than that of insects. Indeed, not all humans would agree amongst each other in the perception of such closely associated colours as pink, red, mauve and purple. This can prove a problem when trying to evaluate which of these colours to recommend to the butterfly gardener. Different colours reflect different amounts of light when illuminated to an equal degree. Ford (1946) maintains that the majority of butterflies take less notice of white than of other colours and also states that purple is more attractive than pink. He goes on to say that the *Pieris* prefer red and purple whereas the vanessids prefer yellow and violet.

My own observations (Table 5) indicate that not all species of butterflies have the same flower colour preference. By listing the name and colour of all the plants on which each butterfly is observed nectaring a general idea of possible colour preferences comes to light. Such information can then be taken into account when choosing potential nectar sources for use in butterfly gardening. My results regarding the *Vanessa* butterflies differ from Ford's (Table 5), nor can I yet agree wholeheartedly with his comments regarding white flowers. His remarks on the subject may prove correct for my area after further, extended observations have been undertaken.

Later on in the season when most flowers are past and nectar is at a premium, the late flying butterflies will search for nectar more randomly, probing such unlikely plants as *Calendula*, and even the fall Crocus (*Cochicum* sp) (Clase and McLeod, pers. comm.).

Purists argue that the "true" butterfly gardener should work solely with native or naturalized plant material, and though I personally may show some sympathy towards this idea, what of the urban or suburban butterfly enthusiast who is surrounded by less than enthusiastic neighbors?

In deference to neighbourhood politics, it is surprising how a few well placed clumps of showy exotics will ease the mind of most urban homeowners. A few patches of French Marigold (*Tagetes patula* "Naughty marietta"), Showy Sedum (*Sedum spectabile*) and Strawflower (*Helichrysum bracteatum*) will usually give the impression that you are truly engaged in some "proper" gardening!

Exotics, if chosen with care, can help fill in the possible gaps between peak blooming periods of your native flora and will also increase the variety of nectar types available to the local butterflies and other pollinating insects.

For those persons wishing to utilize wild flora I have presented (Table 4) a list of the best ten plants for this purpose in my area. My records of nectaring at indigenous or naturalized flora were made both from inside and outside the Parks boundaries but nevertheless, always from insular Newfoundland.

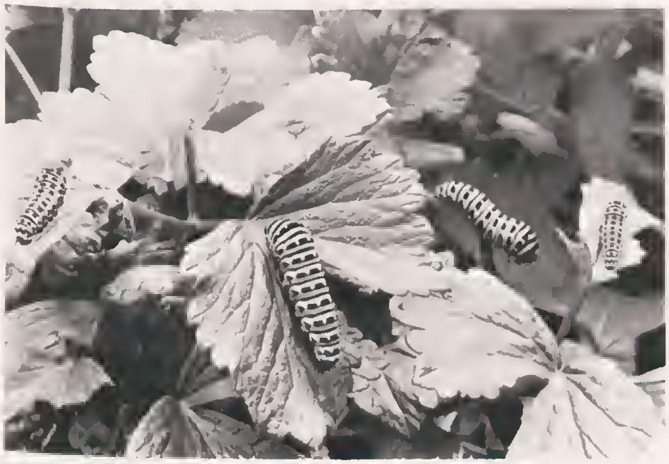

Figure 4. Caterpillar of Short Tailed Swallowtail (*Papilio brevicauda*) on their main local hostplant Scotch Lovage (*Ligusticum scothicum*). Being hand reared from either wild collected eggs or small larvae.

Following the lead of Brewer (1982) I have only included those plants on which I have recorded five or more species of butterflies nectaring. Some of these plants, for instance Joe-Pye Weed (*Eupatorium maculatum*) and Lance-leaved goldenrod (*Solidago graminifolia*) may prove valuable over a large area of North America. On the other hand, Labrador Tea (*Ledum groenlandicum*), a prevelant plant of the Newfoundland countryside, may prove valueless, or almost so, elsewhere. The universally grown (though mostly accidentally) Dandelion (*Taraxacum officinale*) appears of value as a nectar source wherever it occurs. The plant is of particular value to me, in the study area, because it blooms early in the season when other nectar sources are limited and can produce nectar at lower temperatures than many other plants (Free, 1968).

Some species not occuring in Table 4 may still be of considerable value. Indeed, for a particular butterfly, plants of a certain species may be extremely important. For instance, in Newfoundland the leatherleaf (*Chamaedaphne calyculata*) is such a species, being a very valuable early nectar source for the Brown Elfin, a tiny butterfly that hibernates as a pupa (Morris, 1980) and sometimes emerges as early as late April.

Even bearing in mind that some of the butterflies recorded as nectaring on the wild flowers of Table 4 were not present in the study area where exotic nectar sources were readily available, butterflies still appear to have a greater affinity to native or naturalized nectar soures than to exotic ones. This is, I think, quite understandable, since indigenous butterflies would naturally be more familiar with this flora, having presumably evolved with it. It may take some butterflies a considerable period of time (if ever) to adapt to utilizing exotic nectar sources. Others may adapt quite readily, especially if suitable exotic flowers are mixed with native nectar sources or if the local native nectar sources are suddenly made less available. Owen (1977) suggests that the Orange Tip butterfly (*Anthocharis cardamines* L.) of Britain may be becoming increasingly adjusted to suburban life by adapting an exotic plant as a host for its larvae. How much less traumatic would it be for a butterfly to try out new nectar sources introduced to its environment? Members of the *Nymphalidae* always seem to me to be the easiest butterflies to attract and some (for instance the Red Admiral and Painted Lady, that migrate into the study area) seem ready enough to investigate any new flower. The Red Admiral utilizes fourty eight of the eighty two exotics discovered to be useful in the study area (Table 1). One may reasonably expect a migratory species to be more adaptable than one of a sedentary nature with a more specialized habitat.

The quality, quantity, time and length of nectar flow for each individual attractant are factors requiring con iderable scientific attention. They are significant to the butterfly and so also to the butterfly gardener. I would certainly like to see such research undertaken in the

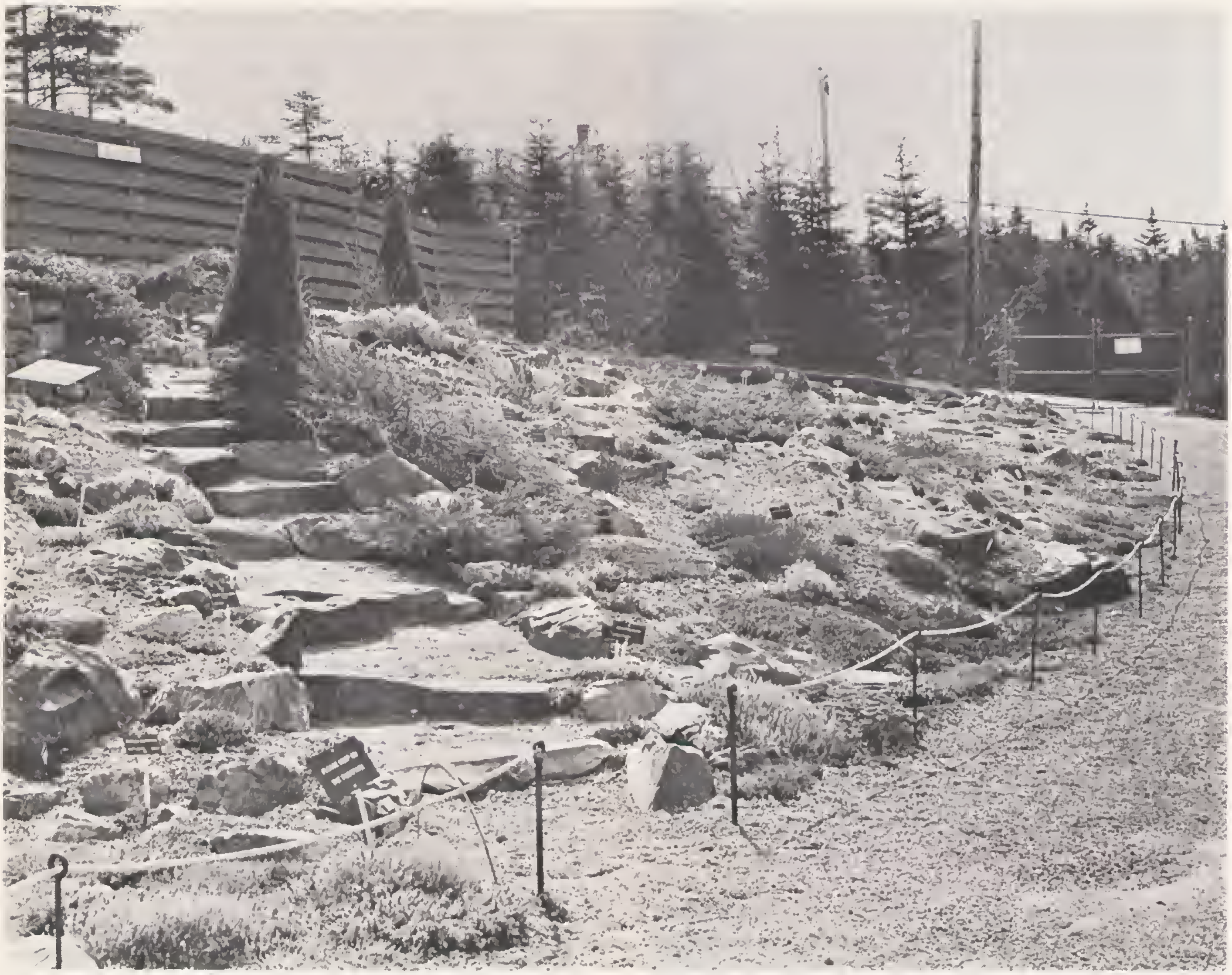

Figure 5. Rock Garden at Oxen Pond in which Short Tailed Swallowtails (*Papilio brevicauda*) oviposit.

study area. For instance, in my area, for a very short period, the Pearly Everlasting (*Anaphalis margaritacea*) is irresistable to butterflies but it very quickly loses its appeal for them. Why? On the other end of the scale, the Lance-leaved Goldenrod attracts butterfiles, mainly Nymphalidae for a prolonged flowering season. Incidentally, this highly scented plant is the only nectar source that I have actually seen attract butterflies away from the Butterfly Bush.

Conclusions

The aspiring butterfly gardener should first become familiar with what species, both of plants and butterflies, are available in his or her own area. Local naturalists and other knowledgable people should be consulted and close personal observation made of any butterfly activity in local parks, gardens and the adjacent countryside (Owens, 1977; Brewer, 1982). I have found this preparatory activity extremely helpful.

Observations would indicate that for those persons interested purely in attracting butterflies and with no outside pressures for formal, "normal" gardening, it would be more advantageous to work largely with native flora (Jackson, 1979a). Indeed, it may be best for the beginner in butterfly gardening to keep to native material, leaving the use of exotic flora for much later (Brewer, 1982).

Of course, the categorizing of plants into exotic and native is confusing, especially when dealing with any other than a very small, isolated area. Our native Joe-Pye weed for instance, is considered an exotic ornamental in some areas. Bouncing Bet (*Saponaris officinalis*) which has apparently become naturalized throughout much of the United States, is a desirable border plant in Newfoundland.

What, if any, is the value of watching butterflies at their preferred native nectar sources, or trying to induce them to exotic ones? It is only one aspect of Butterfly

Production Management but one that can be undertaken and enjoyed by scientists and amateur alike. Much of the well known literature (Klots, 1951; Howe, 1975; Smart, 1975; Pyle, 1981), either through comment or ommission indicate the great need to build up our knowledge of the relationship between specific butterflies and their nectar suppliers. So much of the literature, though covering host requirement fairly adaquately, makes no note of nectar sources excepting in a very general way. The butterfly gardener therefore must gather his or her own information through careful experimentation and observation. Hopefully, when such information is gathered it will be published, so being made available to those of us with similar interest.

Acknowledgments

I would like to thank Jo Brewer whose comments in her paper "Butterfly Gardening" broke my state of inertia long enough to put these few notes together. I would also like to thank David Larson (Biology Department, Memorial University of Newfoundland) Kenneth Proudfoot and Ray F. Morris (Agriculture Canada, St. John's, Newfoundland) for finding the time in already busy schedules to review and make suggestions on this manuscript.

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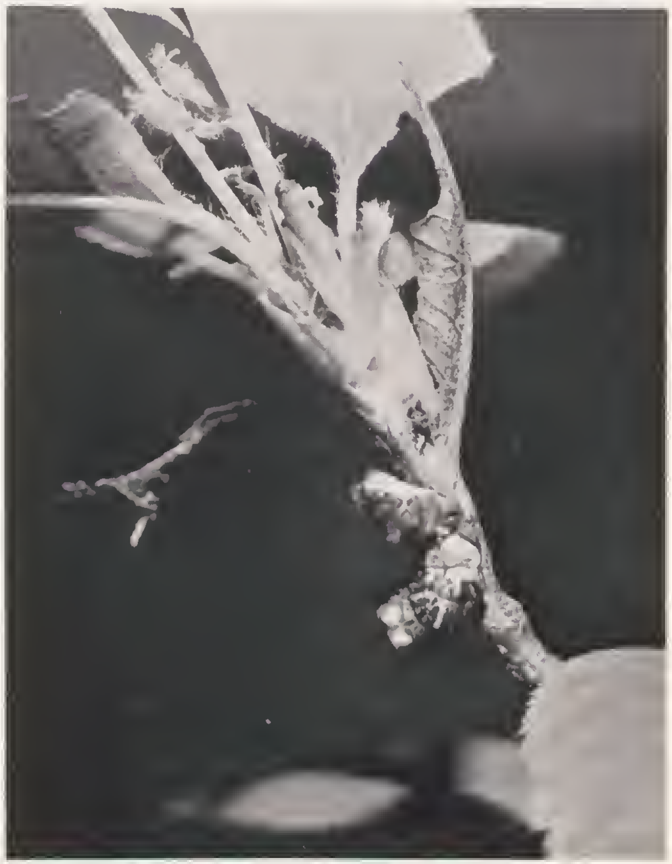

Figure 6. Larva and its old hibernaculum. White Admiral (*Limenitis arthemis*). Reared from egg collected in the wild. Hostplant Chuckly Pear (*Amelanchier bartramiana*).

Book Reviews

Butterflies East of the Great Plains: An Illustrated Natural History. **Paul A. Opler and George O. Krizek. 294 pp. Johns Hopkins University Press, 1984.**

Yet another book on North American butterflies? The last decade alone has brought us a new field guide (Pyle), monographic revision (Howe), and taxonomic catalogue (Miller & Brown), each of which treats all the Nearctic species; and a liberal dose of books dealing with more restricted geographic areas. The stuff of most of these works is lackluster and/or unbalanced, and none significantly improves upon Scudder's (1889) monograph and Klots' (1951) field guide, still the canonical references on eastern North American butterflies. While lepidopterists have grown understandably weary of this protracted parade of bland offerings, they need not worry so about the quality of the most recent product. Opler and Krizek's *Illustrated Natural History* delivers a long-awaited, comprehensive update.

The quality of regional faunal treatments such as the Natural History is generally best indexed not by the mandatory species accounts and lists, but by the introductory, concluding, and interstitial material. For in those sections that authors invariably must expose their facility with matters of substance—ecology, behavior, systematics, and evolution. Thus, the intial 34-page section "The Study of Butterflies" is the *Natural History's* hallmark, keyed by Opler's diverse training in biology and conservation practice, and extended field experience with butterflies. . .and moths, and many other creatures. In that preamble are tempered discourses on larval foodplant specificity, phenology, nectaring biology, thermoregulation, and population structure, among other topics. It and the species accounts themselves are also sprinkled with graphs, tables, and current references to the original scientific literature. The Bibliography thereby amasses over 250 citations, fully 100 to 200 more than offered by the other recent regional works. And what a further, healthy contrast one finds upon pitting the *quality* of Opler & Krizek's references against that of the other works! Opler & Krizek are to be commended for the great service they do as educators in this regard, especially for young and nascent lepidopterists.

There are other high points. The many color photographs of living butterflies are exquisite, well surpassing those in the recent Audubon Field Guide (I have heard some scoff at the *Natural History's* plates, but their dispepsia is misplaced). Neither are the species accounts disappointing. These span the required discussions of habitat, range, and foodplants (largely the *correct* ones), and also include appropriate biological notes. A full etymology is attempted for each species, adding a novel, sometimes apocryphal, yet romantic addition. The distribution maps, which are drawn from the 1983 county-by-county "dot atlas" distributed by Opler and the Office of Endangered Species, are of particular interest. For example, although it is widely known that Hessel's Hairstreak only frequents *Chamaecyparis* swamps—a spotty habitat in eastern North America—its spotty map has an arresting quality which words could never possibly capture. Many of the maps suggest fertile avenues for further research, and the sum of them certainly represents a welcome initial Nearctic reply to the embarassingly well-developed lepidopteran mapping schemes of our Palearctic counterparts.

In short, for broad taste, if you are to purchase but one Lepidoptera book among the many currently available, make it the *Illustrated Natural History*. This scholarly yet readily digestible work is equally at home on the bookshelves of weekend observers and devoted researchers alike. The others are pale in comparison.

—Ed.

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Adult Painted Lady (*Vanessa virginiensis*) basking on flowers. This butterfly migrates into Newfoundland, Canada, and breeds in the Oxen Park Botanic Garden (see article in this issue by Bernard Jackson).

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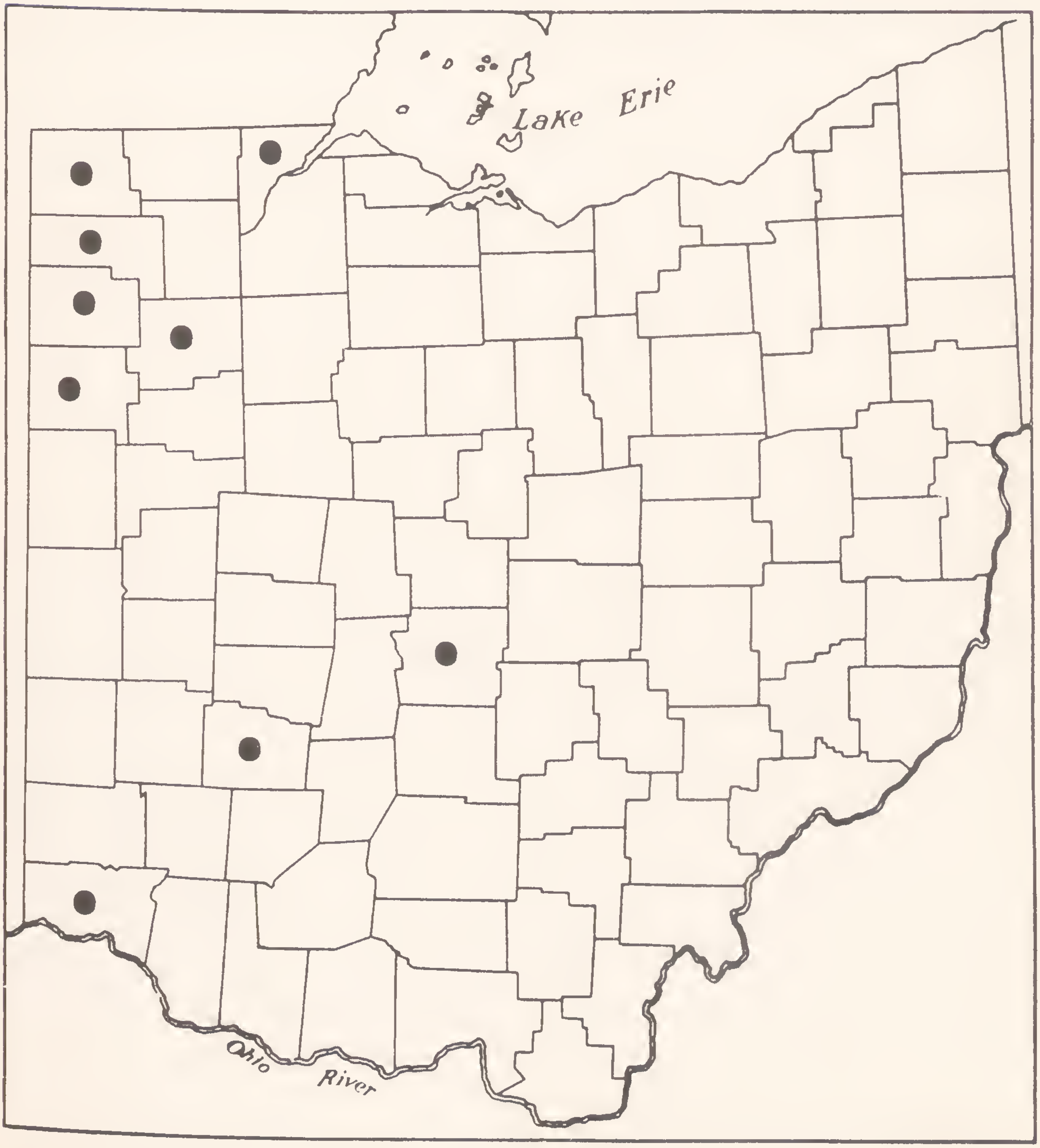

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Articles

The Distribution of *Satyrium edwardsii* (Lepidoptera: Lycaenidae) in Ohio

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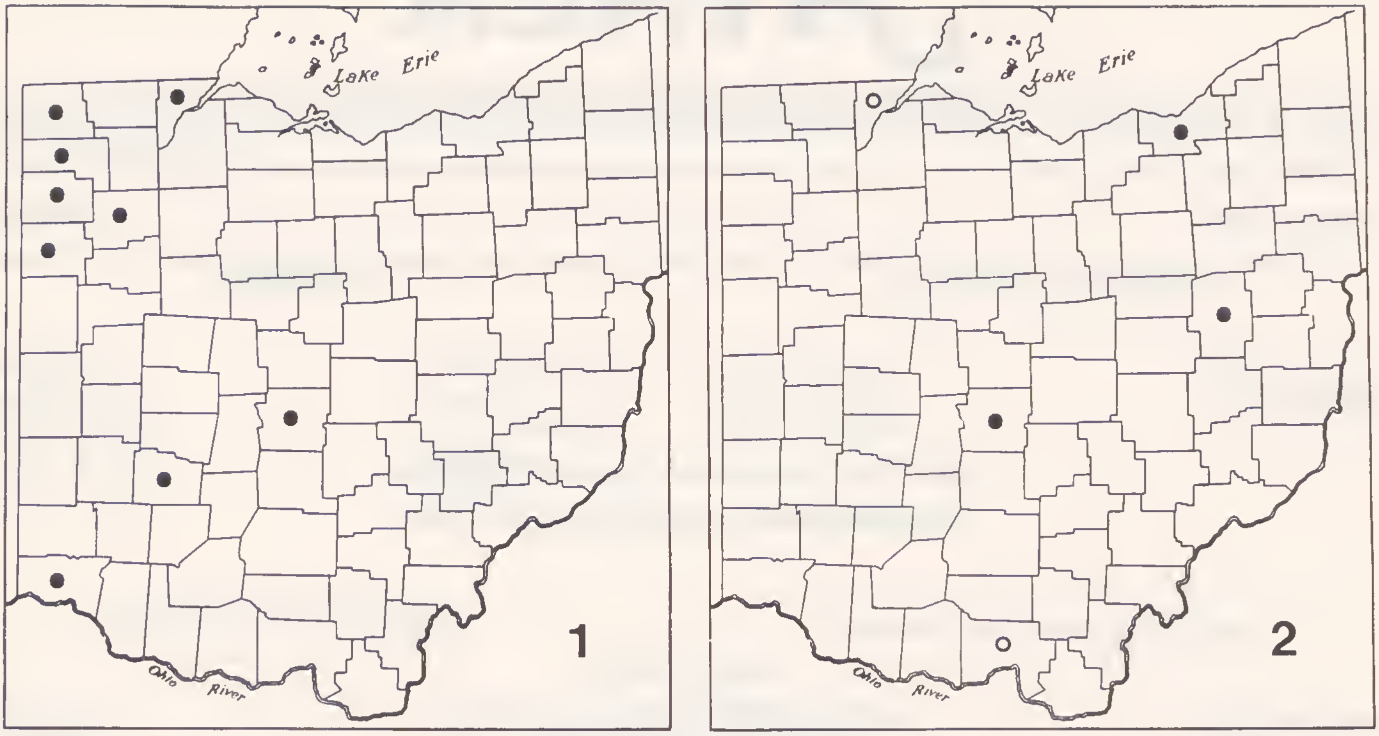
Abstract

***Satyrium edwardsii* has generally been considered to be widespread and common in northwestern Ohio with scattered records through the remaining western portion of the state. However, after reevaluating historical records for this species, it was discovered that most of the supposed records were misdeterminations. Valid records exist for only five Ohio Counties (Lucas, Cuyahoga, Franklin, Tuscarawas, and Scioto). Extant populations are known only from the Oak Openings region in Lucas County where they generally occur in areas of stunted forests with open sand dune topography, and from Shawnee State Forest in Scioto County where they occur in a xeric ridge top community containing prairie-like openings.**

In recent treatments concerning the distribution of *Satyrium edwardsii* (Grote and Robinson) in Ohio, this species is considered to be common in the northwestern portion of the state, while also occuring in smaller numbers in scattered localities through central Ohio (Fig. 1). Price (1970) recorded *S. edwardsii* as occuring in Defiance, Lucas, Paulding, Putnam, VanWert, and Williams counties. Albrecht (1982) primarily cited Price, but also added records from Franklin (first reported by Hine, 1898) and Green counties. An additional record exists for Hamilton county (Wyss, 1932). In Opler and Krizek's (1984) recent treatment of the butterflies of the Eastern United States, the indicated range for this species in Ohio is quite similar to Price's (1970) and we presume those authors based this largely upon Price's work.

Recently, we discovered that the recorded distribution of *S. edwardsii* in Ohio is inaccurate. Erroneous identifications have hindered the realization that this species is one of several butterflies which are known from but a few extant populations in Ohio, and which could be useful as ecological indicators of unique habitats.

While examining part of the Ohio State University Entomology Collection, we discovered that the bulk of the hairstreaks determined individually by Price as *S. edwardsii* were misdetermined. Twenty-one specimens were found to be correctly determined, and were all from the same general locality: The Oak Openings in Lucas county. The misdetermined specimens were all females of either *S. calanus falacer* (Godart) or *S. caryaevorum* (McDunnough), and were collected from Allen, Defiance, Putnam, Paulding, VanWert, and Williams counties. Likewise, the Greene county specimen reported by Albrecht (1982) is a female *S. calanus falacer*. The Franklin county literature record is supported by a specimen housed at the Ohio Historical Society. The yellowed, handwritten label includes only the collection locale, "Columbus, O.". The general appearance of the label suggests that the specimen is old, probably dating to the turn of the century. Although the collector of the specimen is unknown, it may be referable to Hine



Figures 1-2. 1: The distribution of *Satyrium edwardsii* in Ohio, based upon literature records. 2: The distribution of *Satyrium edwardsii* in Ohio, based upon specimens examined. Open circles denote counties with extant populations.

(1898). Wyss (1932) reports the species from Hamilton county, stating that it is in the Dury and Braun collections. However, Dury (1878) makes no mention of this species and we have examined the bulk of the Dury and Braun collections housed at the Cincinnati Museum without finding any specimens of *S. edwardsii.*

In addition to the Oak Openings records, three additional specimens of *S. edwardsii* were found in the Cleveland Museum of Natural History Collection. These specimens, from Euclid, Cuyahoga county, and Dover, Tuscarawas county, extend the verifiable range through Northern Ohio (Fig. 2). The record from Dover is dated "2-VI-1930," an exceptionally early date that is probably in error (the period of adult activity in Ohio [based upon capture dates] begins in late June and extends through July, with a peak in early July; Fig. 3). Recently, a population was also discovered in Shawnee State Forest in Scioto county.

Almost 50 years ago, Rawson and Thomas (1939) suggested that *S. edwardsii* was restricted to the Oak Openings in Ohio. Our records indicate that the majority of the known extant populations in Ohio were located in and around the Oak Openings Metropolitan Park, administered as a preserve by the city of Toledo, and in a few other preserves administered by the Nature Conservancy and the Ohio Department of Natural Resources, Division of Natural Areas and Preserves. Other than the specimens from Scioto county, we have seen no material from outside of the Oak Opening post-dating 1952.

The larval biology of *S. edwardsii* is interesting and may account for its restricted range in Ohio. The recorded larval foodplants in southern Michigan are *Quercus velutina* Lam., *Q. coccinea* Muench, and *Q. alba* L. (Webster and Nielsen, 1984), hardly plants which would account for the restricted range of this butterfly in Ohio given their wide distribution throughout the state (Braun, 1961). However, Webster and Nielsen also found that the larvae were myrmecophilic with the ant species, *Formica integra* Nylander. The distribution of *S. edwardsii* in Ohio could easily be a reflection of the distribution of its symbiotic ant, and not the ranges of the various oak species which serve as host plants. *F. integra* ranges widely over eastern North America (Creighton, 1950), but we know nothing about its habitat requirements in Ohio.

If *S. edwardsii* is dependent upon *F. integra* and/or some other ant species, soil type might be expected to affect their distributions. All of the *S. edwardsii* populations seen by us in Indiana, Michigan, and the Oak Openings of Ohio, and the two sites mentioned by Webster and Nielsen (1984), are characterized by the exremely high sand content of the soils, resulting in xeric conditions. The adult butterflies occur in areas of stunted oak forest usually located on fossil sand dunes. Habitats matching this description in Ohio are generally limited to the Oak Openings (Lucas, Fulton, and Henry counties) and the unique flora which characterizes this region is attributable to the fossil sand dunes which form the bulk of the substrates in the area. The population in Scioto county occurs in an area in which "tall grass prairies are scattered on ridge tops and along forest roads" (Cusick and Troutman, 1978). These ridge top "prairies" occur under xeric conditions and are generally surrounded by oak forests. They are hardly prairies in the usual sense, but rather are assemblages of prairie species which thrive locally under the hot, dry conditions and thin forest cover. Thus, the two habitat types supporting extant populations in Ohio are superficially

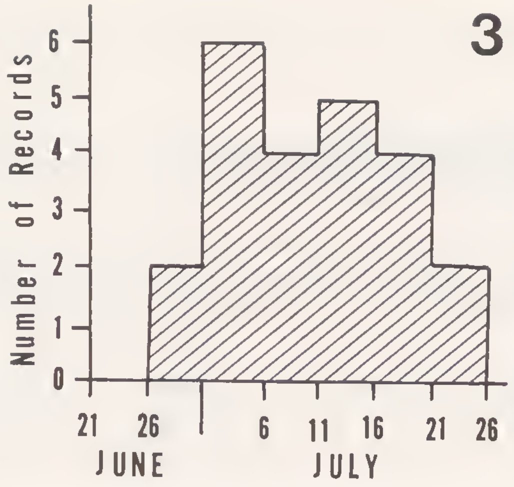


Figure 3. The seasonal occurence of *Satyrium edwardsii* in Ohio, based upon collection records.

similar - both are water stressed, and both are fairly unique as habitats containing large numbers of herbaceous prairie plants.

Occuring with *S. edwardsii* in The Oak Openings are extant populations of four other butterflies which are presently limited to this region in Ohio: the hesperiids *Erynnis persius* (Scudder) and *E. lucilius* (Scudder and Burgess), and the lycaenids *Incisalia irus* (Godart) and *Lycaeides melissa samuelis* (Nabokov). All but *E. lucilius* feed as larvae on *Lupinus perennis* L., itself a potentially threatened species in Ohio, and generally restricted to the Oak Openings (Cooperrider, 1982). The presence of populations of *S. edwardsii* and these other restricted butterflies can and should be utilized in conservation decisions concerning preservation of The Oak Openings ecosystem. Populations of *S. edwardsii* from outside The Oak Openings may be indicative of relatively undisturbed prairie remnants which may also be deserving of preservation.

Acknowledgements

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References to Population Size Estimates of Butterflies

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Abstract

A compilation of published papers in which mark-recapture methods have been employed to estimate population sizes of butterflies and moths is presented, as a bibliographic tool.

Mark-recapture estimates have appeared with increasing frequency in ecological work on butterflies in the past several decades (review by Gall, 1985). The data so derived have been used for estimating vagility, mortality rates, sex ratio and condition changes, and gains to and losses from populations. However, the literature on butterfly population size estimates using mark-recapture techniques is widely scattered. This paper presents an initial, though not exhaustive, list of such studies, and is intended as a bibliographic tool for interested readers.

The majority of the studies listed herein consider butterflies of the Holarctic temperate region, in a variety of habitats. The tropical and arctic-alpine regions are covered less often, but these two are about equally represented. Species of *Colias, Euphydryas* and *Danaus plexippus* L. are among the most frequently studied, along with some satyrids, nymphalids, and lycaenids; papilionids, riodinids, hesperiids, and other pierids are less well represented. Only a few of the listed studies deal with migratory and/or hilltopping species. Studies of gregariously roosting species have been performed with e.g., *Marpesia* (Benson and Emmel, 1973), *Morpho* (Young, 1971), and *Danaus plexippus* (Tuskes and Brower, 1978; James, 1984).

Two thirds of the references provide an estimate of the total size of the population(s) sampled, using various mathematical models. A few studies have addressed the effects of marking and capture upon population parameters (e.g., Singer and Wedlake 1981; Morton, 1982; Gall, 1984a,b), and others have examined the usefulness of different mark-recapture models in the field (e.g., Hanson and Hovanitz, 1968; Arnold, 1983a; Gall, 1984b).

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The Public Benefits of Private Conservation: Specialized Wildlife and Habitat Protection, Restoration, and Management Options

Abstracted from:

The Council on Environmental Quality
15th Annual Report (1984), Chapter Nine
Executive Office, President of the United States

There is an extremely wide range of highly specialized groups, programs and individual efforts to restore and maintain habitat for diverse species of wildlife. Many of these nonprofit organizations conduct significant and intensive programs to protect and restore wildlife, including endangered species and their habitats. Many of them are actively involved in public education to promote their goals, and their activities often complement, and sometimes surpass, the work of such government agencies as the US Fish and Wildlife Service. As this is done at private expense, it makes an important contribution to the provision of public amenities.

Case Study: Sassapaw Research Refuge

The Sassapaw Research Refuge is an 18-acre farm now devoted to studies of Lepidoptera (butterflies and moths) and their ichneumon parasitoids (wasps), and to the protection, propogation and restoration of selected species of butterflies and moths. It is a nonprofit operation.

Robert T. Mitchell, a retired US Fish and Wildlife Service biologist and the co-author of *A Golden Guide: Butterflies and Moths*, and his family in 1970 purchased an 18-acre farm on rolling land in southeastern Anne Arundel County, Maryland, overlooking the Chesapeake Bay, 16 miles south of Annapolis and 22 miles southeast of Washington, DC. As a professional biologist, he had a long interest in and concern for butterflies and moths, many of which have undergone a long-term population decline for a number of reasons. One major cause is likely the decline and loss of butterfly habitat resulting from human population growth and development, as well as modern intensive agricultural and farming practices. It is also thought that the use of agricultural chemicals and insecticides has adversely affected populations.

Declining Populations

Mitchell notes that butterfly populations have suffered as a result of many modern land-use practices, including the construction of impoundments over productive river bottoms and marshes, the draining of wetland for land reclamation, and the removal of thickets and a decrease in the number of woodlots. He notes that the hayfields and pastures which formerly were common across the countryside have been increasingly replaced with shopping centers and asphalted parking lots. The increased number of interstate highways and the improvement and widening of country roads, and in particular the use of chemical and mechanical treatments along roadsides, have taken away much habitat and extracted a heavy toll on many butterflies and supportive weeds. Modern street and parking lot lighting systems and floodlights at shopping centers and at interstate highway interchanges also likely have an adverse impact on moths.

Mitchell also points out that country life-styles have changed radically since his youth. The many small family farms have given way to housing subdevelopments abd larger, more intensively managed farms. Originally, each farm often had a spring that fed a little brook that would be lined with thistles and other weeds which supported populations of butterflies. The cows and horses just ate around the thistles. And people weren't worried about what was eating the leaves on their trees. If people didn't like the dandelions in their lawns, they simply dug them out. Now people treat their lawns and fields with herbicides to remove dandelions, thistles and even clover - which is not only not a weed, but is especially important for a number of butterflies, bees, and other insects.

Most Lepidoptera are highly selective in the food plants and flowering plants that they require at the various stages of their life cycles. In 1970, Mitchell began to manage the farm to develop optimal butterfly and moth habitat. It is no longer solely a working farm. He began a program of introducing plants that would attract and feed a wide range of species. He also began an intensive program of management and manipulation of the various major habitat areas on the farm, which included woodlands, wood margins, open fields, hedgerows, and a special area devoted to food crops for monarch butterflies. Various areas of a four-acre pasture are "bush-hogged" during June, July, and August to produce fresh sprouts and vegetation in three stages of development in order to diversify the habitat. Japanese honeysuckle, which takes over wood margins, strangles trees, invades open woods, and causes preferred plants to die out, is physically removed whenever possible. Other fields are mowed to encourage growth of desired plant species.

Sensitive Farmer

While most of the farm is no longer in production and is instead devoted to maintaining and improving butterfly habitat, Mitchell still likes to be listed as a farmer and complies with the minimum qualification for being a producer - selling at least 50 dollars worth of farm produce. But even where he produces crops, he is especially careful to protect the butterflies. He keeps agricultural chemical applications to a bare minimum, refrains from spraying fruit trees at bloom and, as a result, often produces wormy plums and peaches. And when rotenone is effective, he uses only that as an insecticide.

A small vegetable garden, used mainly for personal consumption, is located near the farmhouse and is surrounded by 0.1 acre plots of red clover and alfalfa for butterflies and mulch for the garden. Even the farmhouse lawn is planted with fruit trees known to be attractive to various species. Various hedgerows have similarly been planted with important trees and bushes, and a one acre mixed pine forest was planted for species dependent on conifers.

Scientific Studies

Scientific studies were begun at Sassapaw in 1979, when Mitchell started butterfly counts. Ten counts, scheduled according to the successive blossoming periods of key plants, are conducted each year along a one and one-quarter mile route that transects the different habitats of the refuge. The data collected include the total number of each species, their sex, behavior, immature stages, ichneumon parasites, etc. It is hoped that over a period of years these counts will enable him to measure the effect of the plant introductions, maintenance operations and habitat manipulations.

Some 30 or more species of butterflies and moths have been located on the refuge, and for some of these Mitchell has made specific plantings or habitat alterations. Mitchell has welcomed assistance in developing the Sassapaw Refuge and has offered to cooperate with anyone wanting to use it for field research studies on Lepidoptera.

Sassapaw is not open to the general public. The farm is 33 miles from his home and Mitchell can't be there at specific times, and because it is not a zoo or a butterfly farm, visitors cannot count on seeing butterflies at specific dates. Instead, from 1 November to 1 May, Mitchell takes his farm/refuge with him on slides for lectures to various groups, showing the butterflies and habitat at their optimal times and also demonstrating what one committed person can do to help protect wildlife and habitat.

This example of private stewardship by Robert Mitchell is a labor of training, love, and concern. There is no money in it. It is used as the basis of his ongoing research into Lepidoptera and provides material for his publications and lectures. He publishes his work and the findings of his studies as scientific papers and delivers lectures, talks, and slide shows. He is able to deduct some of the expenses of the operation from his taxes, taking full advantage of charitable deductions, work-related expenses, etc., and this helps make his conservation work possible.

Creating "Backyard" Habitats

There are indications that a small but growing number of people are becoming concerned about the loss of butterflies and their habitats, and especially about the extensive application of agricultural chemicals and herbicides to country fields and suburban lawns in an attempt to maintain perfect, weed-free lawns, and to produce perfect fruits and vegetables. They believe we may be paying a high toll in the loss of beneficial insects, especially pollinators such as bees, butterflies, moths, and birds. There has, consequently, been a growing movement to return to natural gardens and lawns and to encourage the planting of lawns in native wild flowers rather than persist in attempting, often in vain, to maintain perfect green lawns. However, this runs counter to many country and town ordinances which require that landowners eliminate "noxious" flowering weeds and plants and keep their "artificial" lawns mown and weed free. Also, many housing developments have covenants requiring the homeowners to "maintain" their lawns.

Organizations such as the Xerces Society try to counter some of these mandates by promoting public understanding of the beneficial role of insects in natural ecosystems and the need for habitat protection for butterflies. The Lepidopterists' Society also plays an important conservation role. Beginning in the mid-1970s, there have been an increasing number of popular and scientific articles published on creating butterfly habitat and butterfly gardening. Some people have started butterfly farms for propogation, usually to sell the butterflies to collectors, which may reduce the collecting of wild butterflies.

At least two national wildlife conservation organizations, the National Wildlife Federation and the National Institute for Urban Wildlife, have developed programs for the restoration of natural habitat areas to the urban and suburban landscape, aimed at reversing the shrinking of wildlife habitat.

The National Wildlife Federation is the nation's largest conservation organization. Through the Federation's Backyard Wildlife Habitat Program, homeowners can apply for certified membership in the program. The must pay a nominal application fee, fill out a form with a plan for providing food, water, cover and reproduction areas, and if approved, they are certified and receive a certificate of membership. The Program already has some 3300 members. While devoted to the provision of habitat for a range of wildlife species, the Federation has specific information on butterfly gardening in its 'Gardening With Wildlife Kit.' The Federation is hoping to capitalize on the US Fish and Wildlife Service findings which show that 60 million Americans observe, photograph, and feed wildlife within a mile of their homes, and that 12 million maintain plants to attract and feed wildlife.

The National Institute for Urban Wildlife is dedicated to the conservation of wildlife for the benefit of people in cities, suburbs, and developing areas. It is especially interested in preserving and creating wildlife habitat in heavily populated locales and conducts research and publishes studies on how various wildlife species are adapting to urban environments, as well as on how to improve and create wildlife habitat in urban areas. Their studies have demonstrated the significance of artifical man-created habitats as permanent wildlife habitat. For instance, storm water detention/retention basins create vital wetland habitat within urban and suburban settings. The Institute has retained Robert Mitchell to prepare a booklet on ' Butterflies in Your Backyard.' Many garden clubs have also begun to provide information on plantings that will specifically attract butterflies.

Mitchell says that some people might consider him eccentric because of his attitudes and beliefs. But he notes that he's not opposed to progress and it is not just a growth in human population that is threatening the survival of many butterflies and moths; more importantly, the threat stems from a change in people's attitudes. He notes that increasingly people have been conditioned to be intolerant of inconveniences and nuisances and to demand perfection at the marketplace. They demand and expect perfect weed-free lawns and perfect blemish-free produce. He says that personally, "I feel safer eating the wormy apple and am better off." Through his example and efforts, and that of an increasing number of others who are willing to tolerate some loss to caterpillars and some weeds in their lawns, and who are willing to make space for wildlife habitat, we may continue to have fields and meadows alive with a summer spectacle of butterflies and brightly-colored flowering plants. [Sassapaw Research Refuge, c/o 4109 Tennyson Road, Hyattsville, MD 20782].

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Book Reviews

Ecological Studies of Six Endangered Butterflies (Lepidoptera, Lycaenidae): Island Biogeography, Patch Dynamics, and the Design of habitat Preserves. *R. A. Arnold. 1983. Univ. California Publ. Entom. 99:1-161.*

This book is based upon the author's doctoral dissertation at the University of California, Berkeley. The six species discussed were declared endangered in 1976 under the US Endangered Species Act of 1973, and are as follows: *Callophrys mossii bayensis* Brown, *Plebejus icarioides missionensis* Hovanitz, *Euphilotes enoptes smithi* (Mattoni), *E. battoides allyni* (Shields), *Apodemia mormo langei* Comstock, and *Lycaeides argyrognomon lotis* (Lintner). Chapter 6 which treats *langei* was coauthored with Jerry A. Powell. Chapter 3 which treats *lotis* is a single page (p. 49) owing to difficulty in conducting field observations - only two adult *lotis* were observed at the one known habitat over a three-year period from 1977 to 1979.

The Introduction describes the methods employed for the field studies reported elsewhere in the volume. Included are discussions on quadrat size and orientation, methods for estimating population numbers (Jolly-Seber and Manly-Parr models), marking techniques for mark-recapture studies, three methods for estimating equal catchability and survivorship of marked individuals, spatial distribution, dispersal analysis, and home-range estimation (i.e., standard area of activity).

Part I of the volume consists of five main chapters, one devoted to each of the aforementioned species. Each is organized in a standard format beginning with a prefatory statement about the butterfly under discussion. Subsequent sections include study sites and methods, life history, results and closing discussion. Each of these chapters is liberally illustrated with vegetation maps, histograms related to adult activity and mark-recapture information, adult movement diagrams, and graphs of daily estimated population numbers. Considerable additional field data are presented in tabular form, and most of the information throughout is broken down by study year, allowing examination of seasonal variation throughout the period 1977 to 1979.

Part II consists of two chapters. Chapter 7 is a discussion of the demographic characteristics of the six endangered species and the reasons for declaring them as endangered. Certain aspects of their biology, such as lifespan and mating frequency as determined by spermatophore counts, are compared with other lycaenids found in both the New and Old Worlds. Chapter 8 examines the applicability of island biogeography and patch dynamics to the preservation of butterfly populations. The theory advanced is that destruction of butterfly habitat such that it is reduced to insular areas or patches permits analysis by ecological techniques developed for island populations. Extinction probabilities are calculated for five of the six species (*lotis* being omitted), and these range from 7 percent for *smithi* to 44 percent for *langei*. Recommendations are also offered relative to nature preserves for endangered butterflies. The book concludes with an extensive bibliography.

The species discussed by Arnold live in restricted ecosystems - *Callophrys mossii bayensis* and *Plebejus icarioides missionensis* occur primarily on San Bruno Mountain, and sphagnum bogs are the habitat of *lotis*, with only one site remaining. The other three taxa are associated with coastal sand dunes that are rapidly disappearing as a consequence of urban expansion.

A few minor flaws were noted, such as the spelling *chrysalus* for *Hypaurotis crysalus* and a somewhat inconsistent use of the generic names *Callophrys* and *Incisalia*. On the whole, this study is perhaps too technical for the average reader interested in butterfly conservation, but this is not intended as a popular book. The research should serves as a model to other workers undertaking studies of endangered insects. In this sense, Arnold's book is not a report of field research conducted, but a handbook for conducting ecological studies on endangered insects. Perhaps the most important point made in this book appears on page 152, and this is that butterflies can serve as indicators of endangered habitats. Perhaps as more insects are studied carefully, they too will be recognized as indicator species.

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The Audubon Society Handbook for Butterfly Watchers. *Robert M. Pyle. 251 pp. Scribners, New York, 1984.*

Watching butterflies is an outdoor activity with a rapidly growing number of devotees. The reasons for this are numerous. Increased general awareness of the importance of our natural environment and the organisms it supports has aroused public curiosity about these insects. As one focuses more closely on butterflies, it becomes apparent that they rival and exceed in beauty the flowers on which they feed, and that their live surpass in beauty and complexity those of the birds that feed upon them. More and more people are adding butterfly observation to their pursuit of birds or wildflowers.

Additional impetus has come, perhaps inadvertantly, from the camera industry. As camera technology has advanced explosively over the past two decades, superb butterfly photographs have appeared with increasing frequency in magazine articles. The reader is inspired to say "I want to see that," and on seeing it to vow "I'm going to photograph that butterfly!" With a single lens reflex camera and a macro lens, the goal is attainable.

To reduce the need for the beginning butterfly watcher to proceed solely by trial and error, Robert Pyle has produced a quite comprehensive book about butterflies: their characteristics; life cycles; behavior with regard to feeding, mating, and egg-laying; and the problems they must deal with in order to survive. Locating butterflies, both as to habitat and as to season, is considered in detail in the *Handbook*, as is the important matter of approaching a butterfly in such fasion as to avoid frightening it away.

Photography is treated in an adequate but simple fashion – as it should be. While a lengthy book could be written about the finer points of close-up nature photography, the fact is that a good camera, a good lens, and a good approach adds up to success and satisfaction. No one should shy away from this most challenging and rewarding part of butterfly watching.

The question of collecting specimens, and the compatibility of collecting and conservation, are discussed in an enlightened and informative manner. It is clear that in most instances the crux of conservation lies in preservation of essential butterfly habitat. In only a few limited situations is collecting per se a major threat to the survival of a butterfly population.

The butterfly watcher is instructed as to the value of field notes and the need for proper data-labelling of photographs and specimens. Pyle emphasizes the need for, and the means of, accurate identification of species in order to make notes meaningful. The role of butterfly watching in the teaching of natural history is delinieated, and methods for counting and for mapping the distribution of butterflies are explained. A rather lengthy section catalogs locations in North America and abroad which are renowned as butterfly observation sites.

From the point of view of this reviewer, the chapter "Moths: Learning to Love Them" is a most welcome inclusion. Since the number of species of moths in most areas exceeds that of butterflies by a ratio of 20 to 1 (or more), and since their diversity in color, size, and lifestyles competes favorably with that of butterflies, moths deserve more open-minded attention than the public is inclined to accord them. Pyle deserves great credit for including them.

There are occasional errors of fact which one hopes may represent "typos" or editorial oversight. Contrary to Pyle's statement, it is the female in birds and Lepidoptera which carries the sex determining Y-chromosome, in contrast to mammals and most other animals (where the Y is the male determinant). Also, the chemoreceptors with which butterflies "taste" vegetation before egg-laying are located in the forefeet, not the hindfeet. In fact, the forefeet of nymphalids, far from being "useless brushes," bear these same sense organs. One can watch the female American Painted Lady tap-tap-tap on the leaf of the Pearly Everlasting with her brush feet – having found the right location, she then steps forward and deposits an egg among the leaf fuzz at that exact spot.

The reader should note that the chrysalids depicted on page 18 are erroneously numbered. The number one should be in the upper *right* corner, with the numbers continuing sequentially in a clockwise direction.

An unfortunate feature of this book is the repeated reference to the author's personal accomplishments. Valid though these accomplishments may be, they distract the reader's attention from the avowed focus of the book: watching butterflies. It is rather like a cloud passing before the sun on a good butterfly day.

Sarah Hughes' illustrations of butterfly biology and behavior are superb, bringing added life to the phenomona discussed in the text. They are the perfect complement to a book which has so much to offer the novice as well as the seasoned watcher. The *Handbook* should be enjoyed by all who have the wisdom to let butterflies brighten their lives.

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The Biology of Butterflies (Symposium of the Royal Entomological Society of London, Number 11). *R. I. Vane-Wright and P. A. Ackery, Eds. Academic Press, London, 1984.*

Purchase the book if you take your lepidopterology at all seriously. That addresses the overall picture quite sufficiently. Of course, the thing is most certainly not without its peculiar flaws, although in fairness this review often deals with shortcomings inevitable in any such tome covering comparably broad terrain.

The butterfly symposium itself took place in September 1981 at the British Museum of Natural History, coincident with the eightieth year of Prof. E. B. Ford, in whose honor the event was dedicated. A star-studded cast of 44 signed off on the 33 articles ultimately shepherded to press by the capable hands of Vane-Right and Ackery. The articles are organized into eight major areas of research on butterfly biology, which here seem most sensibly grappled with in the order in which they appear.

I. Systematics

Since this is a volume on butterfly biology, it is not surprising that butterfly taxonomy is allotted only minimal page space. Indeed, Ackery sequesters such considerations in but the first 13 pages of the total 429, with a healthy chunk of that devoted to recounting and judging faunistic works of the world. All in all, we hear relatively little about butterfly faunistics as compared to butterfly taxonomy (and, of course, bloated and imbalanced work on limited faunas seems to be the relentless vogue in the latter). Not so with Ackery's concise and bibliographic faunistic summaries – hats off to him for skipping the pedestrian, and pointing the way into an important yet often neglected literature.

II. Populations and Communities

This section contains two lengthy and two very brief articles. An Ehrlichian overview of population structure *sensu strictu* is both expected and appropriate in a volume of this stature, since the Stanford studies are among the forerunners. I've read essentially everything the Ehrlich group has put out over the years, and this is one of the most readable and widely appealing of their available reviews. More is known about population structure in *Euphydryas* than in most other species, and it is sobering indeed to hear Ehrlich berate his favorite creatures, and call for studies on a less biased taxonomic sampler of butterflies.

Gilbert then expands the focus to entire butterfly communities; given Ehrlich's caution, it is no surprise that generalizations are even fewer here. In short, the number of possible explanations for observed patterns increases explosively as one moves from single to multiple-species studies (infrataxonomic differences even notwithstanding). As a synopsis of this still nascent field Gilbert's article is fine. A gem within it is the paraphrasing of Munroe, who in his thesis had written the kernel of island biogeography well before it was popularized by MacArthur and Wilson's subsequent monograph. However, Gilbert quotes Munroe to establish a sad point, namely that "the slow progress of butterfly ecology [is because] ...it has often been an afterthought of systematic or genetic studies."

The final two short articles in this section do not belong. Pollard's simply doesn't begin to do justice to the important field he has helped to engineer. Read his journal articles on relative abundance instead, and the terminal paper in the symposium volume. Morton's asks how the process of marking butterflies influences their subsequent activity. While there has never been much doubt that mark effects occur commonly, there are also few published studies addressing the issue. Morton's paper is generally helpful in this latter regard, but his data are useful only insofar as one tolerates the failure to measure catchability differences, and other factors central to analysis of recapture probabilities (see below).

III. The Food of Butterflies

This third section mirrors its predecessor in having two long and two short articles. Chew and Robbins lead off with one of the long ones, on egg-laying in butterflies. Their article embraces a large literature, hitting subtopics as diverse as oogenesis, selecting oviposition sites, and the evolution of oviposition specificity. Give them an 'E' for effort. It is partly the magnitude of their selected topic (too broad for one article), but mostly their choppy prose and superabundant citations which run the article aground. Large segments of the text are choked with 2-3 times as many references as necessary, and accordingly this is one of the more difficult to read among the symposium articles. Scan through it for the goodies to your liking. Their final section is probably the most provocative, and ushers in the notion of 'larger-scale evolutionary jumps,' a subject taken up independently in other contexts by other authors in the volume.

Singer, whose writing is vastly clearer, addresses a restricted but closely related array of topics. He first reviews host discrimination by females, and then turns to the consequences of female choice upon (the essentially shipwrecked) larvae. A trademark of Singer's is careful scrutiny of intervening variables – what might loosely be described as the dozen or so factors you couldn't measure, but which your critics seize upon with glee. His trademark is evident throughout the latter half of this article (e.g., pages 85-87). It makes for tempered discussion, and, consequently, good reading.

At the end of this chapter are two more brief articles. Courtney's is scarcely a page, is merely a listing of homilies about habitat and foodplant selection, and again does not belong in the volume. My advice is the same as for Pollard's effort in Chapter II: go read Courtney's fine original research papers instead. Edgar's short data paper marshalls believable evidence that plants in the family Parsonsiae represent ancestral foods for danaines and heliconiines.

IV. Predation, Parasitization, and Defence

This section contains a smattering of articles dealing with threats to butterflies – who eats them, where, when, and why, and the consequences in evolutionary time. Dempster asks the damaging question: what in fact do we know of the natural enemies of Lepidoptera themselves (cf. the abundant indirect evidence of their effects)? The essential lesson from his lead article is straightforward, and can't be emphasized enough – we know depressingly little about the influences of natural enemies on lepidopteran populations in the field. Lane's tantalizing short second article, on ectoparasitic midges on butterflies, only reaffirms Dempster's point (an excellent parallel treatise to Lane's is Treat's book on moth mites). In sum, our understanding of predators and parasites remains in 'seek and describe' mode.

These tentative articles give ground to Brower's methodical and exacting dissection of lepidopteran chemical defense. The longest of the Symposium articles, it is also among the best, a basic and refreshing subplot within it being re-categorization of the myriad terms applied in the literature on chemical defense and mimicry. Brower first establishes these theoretical constructs, and then marches into the fray and sorts through the booty of published, often fragmentary information. His differentiation between Class I (noxious) and Class II (innocuous) defensive chemicals becomes central to arranging the mess, and understanding the roles played by diverse assemblages of chemicals in the overall picture of chemical defense. Brower's attention to spatial and temporal diversity in predator behavior is similarly welcome. As with Singer, Brower has the keen eye for how to deal with observed variation in a systematic fashion.

Marsh et al.'s short article has the unenviable distinction of following Brower's and preceding Turner's. Their idea is laudable: test the anti-tumor action of various lepidopterous extracts. But the data are few (though interesting), and the recitations smack a little much of the narrow approach against which Brower just finished campaigning so successfully.

Turner opts for the moderator's stance, balancing opposing arguments while dismantling traditional dichotomies between Batesian and Mullerian mimicry. This he caps off with a lengthy and poignant discourse on saltational genesis of mimicry complexes. Indeed, by the end of the article, Turner has roamed fully into a general treatment of neo-Goldschmidtian punctuationalism (his tongue-in-cheek "evolution by jerks"). Throughout he draws upon the exemplar tropical heliconiine-ithomiine mimicry rings to bolster specific arguments. Turner's temperance helps to unravel the various concepts, and his article can certainly stake its claim as an educated precis on mimicry.

The reader must again endure two plus pages of the suboptimal after a masterpiece. In their introduction to the symposium, Vane-Wright et al. indicate that Gibson's automimicry article "generated much discussion... at the meeting." Within the walls of said meeting is where this off-the-cuff model should have stayed to ripen a bit. Field workers with an accompanying feel for modeling will have little difficulty flagging the several tenuous assumptions and their scant support from data. For automimicry, start with Brower et al. (1967), et seq., and work yourself forward through the literature from there.

V. Genetic Variation and Speciation

Leading off the second half of this volume is a variegated assembly of papers dealing with microevolutionary matters. Brakefield's is the principal article, a classical British ecological genetic investigation of spotting pattern in satyrines. He devotes the first ten pages to detailed and data-intense elaboration on the classification and heritability of these demure undersurface spots, and then traverses a shopping list of selective pressures potentially responsible for the geographic and populational variation in spotting.

The "boundary phenomonon" is certainly among the funkier discordant morphological patterns thrown by *Maniola*. The undersurface spotting regime of this butterfly shifts abruptly along a front only dozens of meters wide in southwestern England, and the front itself moves about in both time and space. There is still no overpowering explanation for this pattern, despite several decades of research. Brakefield somewhat belabors the ambivalent results with this and other aspects of the *Maniola* story, but gets on track with his own thing – the spots as anti-predator devices, fluctuating selective pressures, and a healthy plea for populational work on the immatures.

Brakefield's plate of 119 'pressed' *Maniola* on pages 174-175 is a welcome sight. (It reminds me of the cabinets full of quite prostrate Gerould *Colias* who have cohabited over the years with me in my niche in the museum). More importantly, of course, it is just about the only visible affirmation in the symposium that properly executed morphological work has always been and will always continue to be central to good evolutionary study. This too often gets billed as an antiquated tenet, in this heyday of gelled and pureed creatures (and narrowly defined biochemical jobs in evolutionary biology, and divested museum holdings).

Kitching picks up on the subject of chopped butterflies in the second article, but only offers a breezy two cents' worth on his electrophoretic work on danaids, and the possible concordance between his data and the morpholgical cladistic treatments of Ackery and Vane-Wright. Of what value is that? Granted, there are concerns other than review articles when one is completing a doctoral dissertation, but what an apparently lost opportunity for a coming lepidopterist to publish some hot-off-the-press research in a major tome. So, why?

Gordon follows with a brief yet stimulating notion that mimicry (and possibly speciation) in east African *Acraea* is linked to dispersal, which in turn is linked to patterns of local extinction. Though he errs in the same manner as others throughout the symposium by equating differences in recapture probability entirely to one of its several confounding components (in this case, to dispersal), his continued pursuit of the subject should uncover some treasures.

Pierce wraps up with another short piece, but one which strikes an appropriate balance between the data presented and the conclusions drawn. The suggestion that lycaenids speciate more rapidly because of low deme sizes and selection by females for both foodplants and 'ant'plants is most plausible. We can also now add lycaenid larvae to the growing list of bizarre entomological edibles.

VI. Sex and Communication

This is the most mature chapter overall in the volume; and Silberglied's is easily the best paper in this chapter, being both provocative and scholarly in content and well written. Smith's is a close second, with the differences in approach and opinion between he and Silberglied appearing to be in large part semantic (or reflecting 'taxonomic scale,' cf. the Introduction).

Silberglied treats us first to Darwin's views on lepidopteran coloration and an accounting of its diversity, and then settles in on visual signals important in male and female communication, respectively. His take-home message is that female butterflies choose not on the basis of visible male colors, but rather on the basis of UV signatures and smells; he leaves us thinking along intrasexual lines for explanations of male butterfly colors.

Smith analyzes mate selection in *Danaus* and *Hypolimnas*, offering one of the better blends of data and discussion in the volume. A main thrust of his is distinguishing between random preferential mating, and assortative preferential mating. It remains to be seen whether Smith's complex findings are generalizable throughout Lepidoptera. However, Smith takes high marks among the 44 authors for his frequent admonishments about the inadvisable lumping of heterogeneous sub-classes of data, and the certainty of subsequent errors in interpretation.

Three shorties follow. Platt et al. offer a short data paper conclusively showing lack of differential mate selection in tiger swallowtail morphs. Vane-Wright notes, in particular, how male narcissism might be a unifying force for apparently equivocal and/or puzzling results in butterfly ethology. Finally, Clarke talks a little about sex-ratio distortions in gypsy moth and *Hypolimnus* broods.

The terminal paper, by Boppre, addresses the chemical aspects of communication among butterflies. Admittedly, much of our general knowledge of this subject comes from experiments with moths – with butterflies, it has been largely anecdotes, some major works notwithstanding. Boppre dutifully covers his material (androconia, pheromones, associated behavior, etc.) but in at least twice the number of words required.

VII. Migration and Seasonal Variation

Baker's is the primary paper in this Chapter of only vaguely related articles, offering a glimpse into what governs the movement of butterflies. His temporal frame of reference is substantially longer (lifespan) than that typical of published work on butterfly movement (days or so), and this imparts to Baker a different and healthy perspective. Indeed, he treats topics such as direction ratios that often never surface in more conventional mark-recapture studies, and it is encouraging to see such initial advances in a curiously neglected field (after all, butterflies fly, and so why don't we know more details about their travels than we do?).

From flight we jump inexplicably into study of seasonal polyphenism, cast in the light of genetic assimilation. Shapiro reworks a theme he has been publishing on vigorously for a decade, though in this paper he treats us to data from some new taxa. I agree with the editors that Shapiro's effort is heroic despite equivocal results; he is also a bigger man than most to confess at the end that "if ... [so], one need only invoke ordinary Darwinian selection to evolve polyphenism, and neither genetic assimilation nor anything more arcane is necessairly required." See his Figure 27.5 if you have doubts as to the genetic (cf. environmental) basis of polyphenism.

Chapter VII continues its schizophrenia by shifting to an illuminating short piece by Porter on larval basking, and its probable link with efficient digestive activity. Two more brief, descriptive polyphenism papers follow: McLeod on *Precis*; and Yata et al. on *Pieris* (the latter being of some intrigue since it treats polyphenism in the immature stages).

VIII. Conservation

Pyle is the prime popularizer of lepidopteran conservation worldwide, and an article from him is obligatory. Here he focuses on the recent eruptions of Mount St. Helens in western North America, and the influence this literally earth-shaking event had on butterflies in the area. Glean the more general of Pyle's points, since the data are necessarily scanty and inconclusive (the appropriate comparative pre-eruption lepidopteran research sadly doesn't exist).

The second article by Parsons examines the distribution, biology, and conservation problems faced by the world's largest birdwing butterfly. While Parsons talks about habitat loss (e.g., encroaching oil palm plantations) and factors affecting foodplant distribution, he unfortunately didn't give air time to an intriguing, tested, and successful option – 'butterfly farming.' This novel technique simultaneously eases commerical demand for specimens without impacting wild populations, puts cash into the local economy, and (probably most importantly) fosters local interest and commitment to the conservation ethic. Parsons' repeated citing of internal agency documents on the matter of butterfly farming only makes one yearn further for an expose in the more accessible, true public record.

This brings us to the ultimate paper in the volume. And it *is* the apex – a masterly review by Thomas of lepidopteran conservation efforts in temperate countries. I can't praise it enough. In fact, it is pointless for me to waste your time recapping it here, except to say that it shows pithy insight on all aspects of complex conservation issues, including: the acquisition and analysis of data on population changes, pinpointing the factors responsible for the observed changes, the associated political and sociological backdrops, and how these three avenues of inquiry are (or aren't) translated effectively into day-to-day conservation practice. He certainly doesn't shy away from flagging the dismal failures among the gamut of conservation attempts.

Thomas really does have a handle on the 'big picture,' and I strongly urge that his paper be read carefully, with an eye toward integrating the lessons of the other 32 papers into the unifying framework offered in the 33rd. It is a fitting wrap-up indeed for this symposium – lepidopteran conservation efforts have been gaining momentum during their formative period of the past two decades, and stand to mature in their own right during the remainder of this century.

As you have gathered, the symposium articles fall broadly into two size (and content) classes – very brief reports of narrowly defined studies, and long review articles. The short reports are of inferior quality, and detract from the impact of the symposium volume as a whole. Why juxtapose notes of passing interest alongside more permanent, scholarly reviews? After all, we have journals for the express purpose of communicating such short notes (and journal referees to reject the bad ones).

Obviously, I don't feel these short notes at all served the editors' stated intention (page 1) of amplifying or highlighting accepted dogma or difficulties. Nevertheless, there are other factors which editors must weigh (such as affording equal air time to all participants in joint ventures). While one may dislike the schizophrenia imparted by the short papers, Vane-Wright and Ackery can't be held wholly accountable for problems inevitable when concatenating as many as 33 papers. Choppiness is one such unavoidable problem.

Leaving style aside, one large matter of substance glares at me through these several hundred pages of otherwise excellent lepidopterology. Why is it that mark-release-recapture takes it on the chin in this volume? I see much innuendo on supposed 'problems with MRR,' especially the business of marking itself, but little concrete offered in the way of justification, let alone alternative methodology.

It is telling that authors in this symposium make essentially no mention of Tabashnik's research on sulphur butterfly population structure, insofar as it applies to the theory and practice of MRR (nor do they speak of Begon's 1979 book). Tabashnik's 1980 paper, published in Oecologia, is the seminal work in recent years dealing with the partitioning of recapture probability into its biologically distinct components. Not one author attempted to break down recapture probability here, yet each tried to interpret recapture probabilities. There is little excuse for continued unthinking analysis of recapture probability as if it were a unified whole. Catchability and residence are *different*, they *combine* to form recapture probability, and the distinction is paramount. Age structure is also easy to monitor (via wing wear), and it too is central, but again few authors bothered to report it.

These are unsettling omissions. I get the impression that this pooh-poohing of MRR is traceable in large part to the intermittent reports detailing detrimental effects of marking (as championed in part by Morton here, and others elsewhere). Really, though, so what if marking effects exist? They're present by definition. This begs for tempered investigation of their impact on populational parameters, not thoughts of rejecting MRR as the basis for measuring population size. The fact is that few have cared to ask critical questions in this area. Non-marking techniques certainly have their place, but they can't yet supplant MRR, and doubtfully ever will.

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THE XERCES SOCIETY

Preliminary Notice: 1987 Annual Meeting

10 - 13 June 1987

Gainesville, Florida

Come one, come all! The 1987 Annual Meeting of the Xerces Society will be held in Gainesville, FL from Wednesday 10 June 1987 through Saturday 13 June 1987. The meetings will be hosted by the Florida State Collection of Arthropods, with overnight accomodations being provided through the University of Florida. Dr. Tom Turner (Clearwater, FL) is the principal coordinator for the meeting.

This is the preliminary notice -- to whet your appetite, and allow you to plan your 1987 summer excursions early. We will be distributing a more detailed notice, including a formal call for papers, in the winter months.

Wednesday	10 June 1987	Welcome & registration (am) Contributed papers (am, pm)
Thursday	11 June 1987	Invertebrate symposia (am, pm) Banquet/entomophilia auction (eve)
Friday	12 June 1987	Contributed papers (am) Presidential address & elections (am) Barbeque (pm, eve)
Saturday	13 June 1987	Field trip

Early summer in northern Florida should provide excellent entomological viewing, perusing, and collecting. A field trip to local "hot spots" is scheduled for most of the day on Saturday. In addition, if enough interest is shown in advance, a field trip to the intriguing Florida Keys area can be arranged. Persons interested in this optional Keys field trip should contact Tom Turner NOW at the address given below.

This Xerces Society meeting will feature symposia on biological & conservational aspects of both marine and freshwater ecosystems, and papers dealing with these topics are especially solicited. Abstracts and requests for time slots for contribued papers should be addressed to Tom Turner. Other general information may be obtained by contacting the Xerces Society office (Melody Allen, Executive Director) at 10 SW Ash Street, Portland, OR 97204, tel: 503-222-2788.

FOR ADDITIONAL INFORMATION CONTACT:

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INSTRUCTIONS FOR CONTRIBUTORS

Formal scientific articles and notes dealing with any aspect of the ecology and conservation of invertebrates and their habitats are solicited. Articles will generally be longer papers, notes not exceeding 1000 words. Reviews of books dealing with invertebrate conservation or endangered habitats are also invited. Appropriate philosophical papers will also be welcomed.

All manuscripts should be typewritten on white, 8.5 x 11 inch, good quality bond paper, on one side only, double- or triple-spaced throughout, with margins of at least one inch on all sides. Manuscripts produced on dot matrix printers are *unacceptable* unless the printer has been set in near letter quality mode. The original manuscript and 2 copies should be submitted; authors should also retain a copy of manuscripts and figures for later consultation with the Editorial Staff.

Include illustrations and/or black and white glossy photographs as appropriate. Figures should be consecutively numbered in Arabic numerals. Hand-drawn figures should be rendered in black ink on good quality white paper, and may be larger than the final reproduced size. These and artwork will be returned after publication if accompanied by return postage. Figure captions should be typed, double- or triple-spaced on a separate sheet, and the number of the figure lightly pencilled on the back of each drawing or photograph. A map should be included as a figure with all articles dealing in a major way with a specific region or invertebrate habitat. Tables should be numbered consecutively in arabic numerals, and submitted on separate sheets in *camera-ready condition.* Cover art/photos change with each issue, and contributions will be gratefully received. Cover material should generally show invertebrates in natural settings, and prospective cover artists should consult with the Editor prior to submitting material.

The style of *Atala* generally follows that recommended in the *CBE Style Manual* (1972). Abbreviations of journal titles follow *Bibliographic Guide for Editors and Authors* (1974). Please include full scientific name, *with authors*, for both plants and animals mentioned in any manuscript submitted for publication in *Atala.* Dimensions should be given in *metric* units. Full references to literature cited should appear in a separate section at the end of articles or commentary papers, but parenthetically incorporated within the text of notes. Please include an *informative abstract* of approximately 100-200 words with all articles. Avoid footnotes whenever possible; such information can usually be incorporated into the text. Words to be set in *italics* (including scientific names) should be underlined.

Page charges are $10.00 per page, and waivable *only* when institutional funding is unavailable or when hardship can be demonstrated. Reprints of papers accepted for publication are available at cost. An author will receive an order form for reprints and page charge instructions at the time galleys are sent for inspection.

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COVER

The distribution of Edwards' Hairstreak, *Satyrium edwardsii*, in Ohio based upon collection records. Upon close inspection of the specimens, many of the records proved to be in error – the species inhabits a more narrowly restricted range and habitat in the state than previously thought. See the lead article in this issue.

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